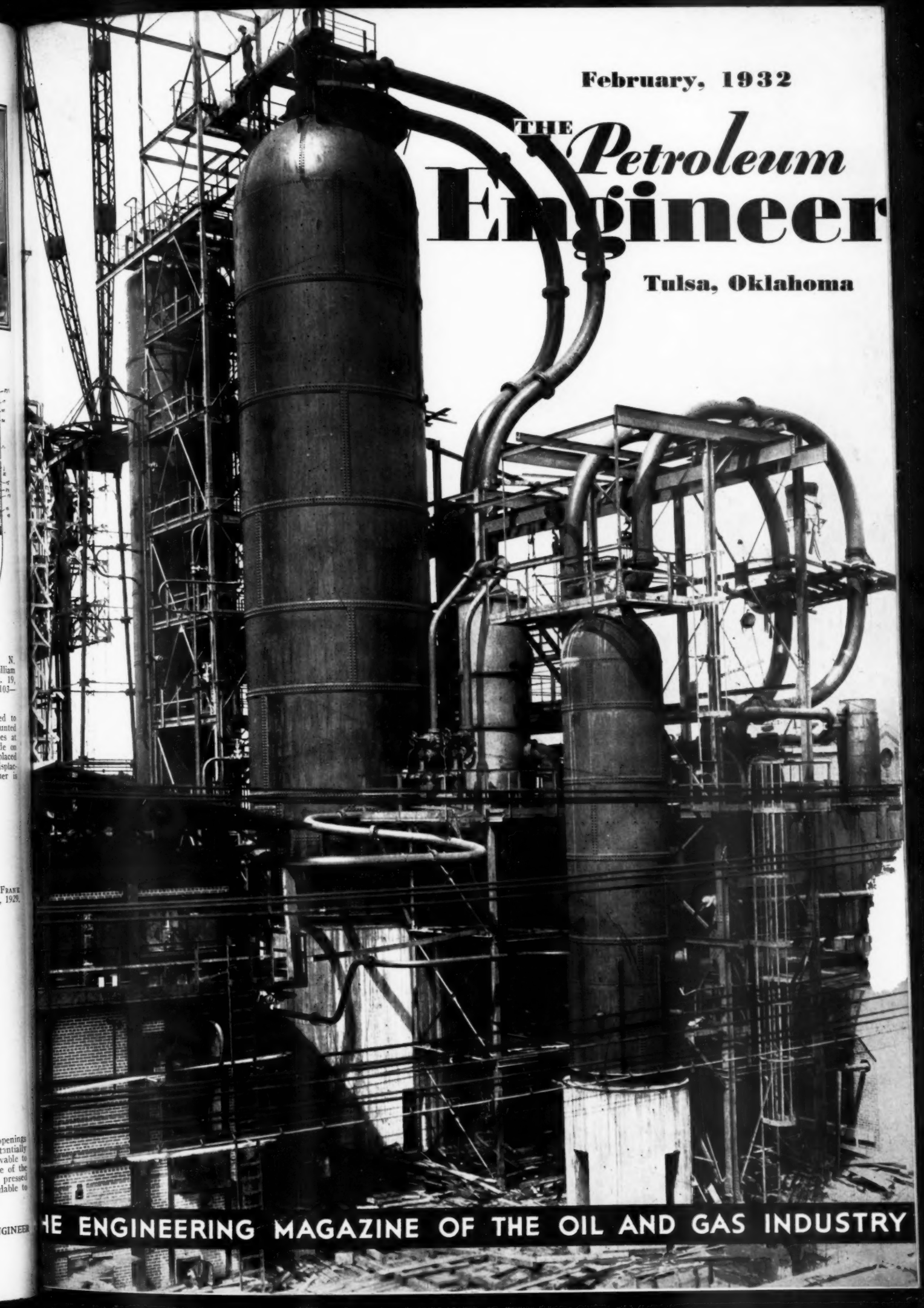
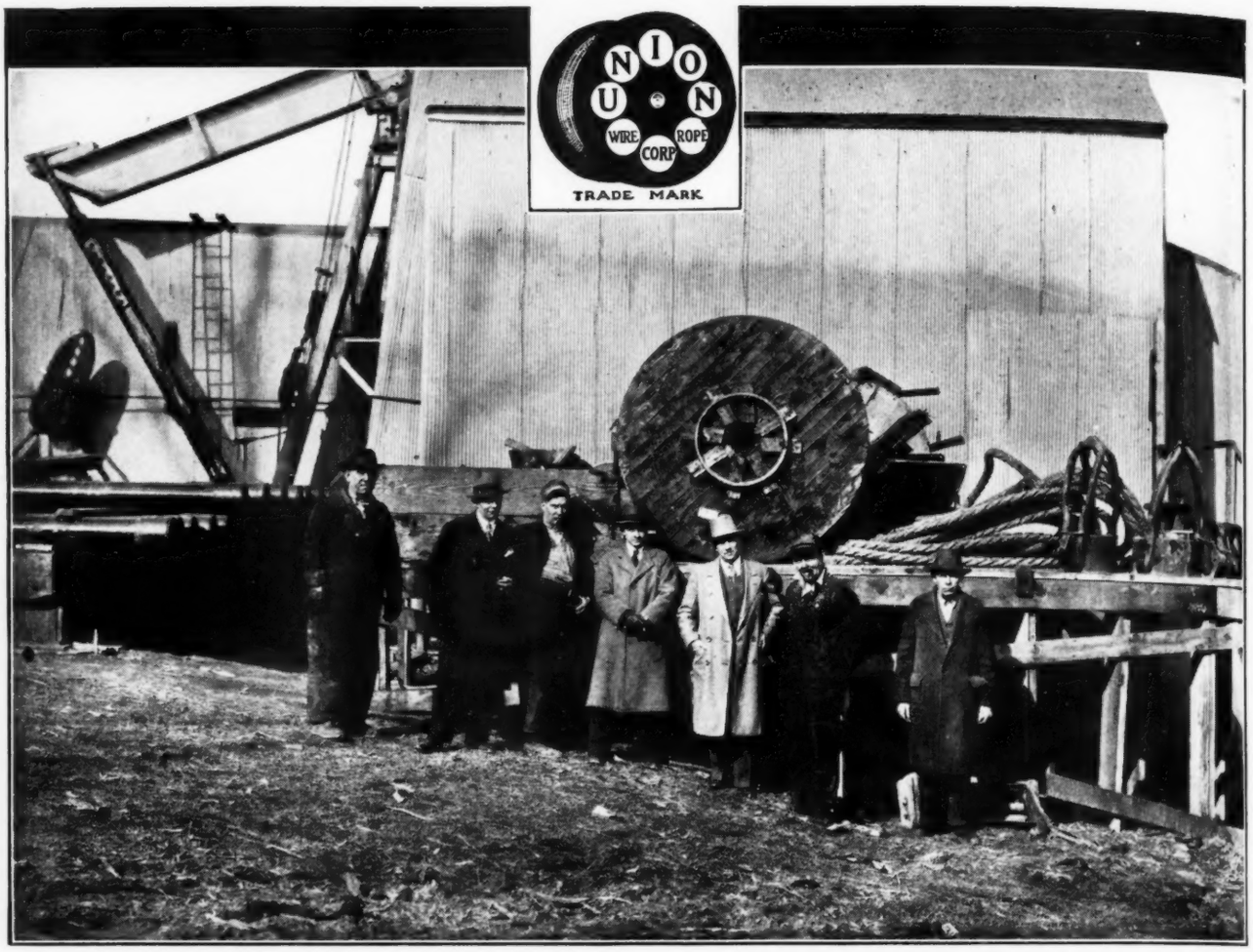


February, 1932

THE Petroleum Engineer

Tulsa, Oklahoma

HE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY



UNION Wire Lines Drill Deep in Ohio—

SHOWN above is a well in Sect. 26, Jefferson County, Ohio, with the 10" hole at 5000'. A 1" x 7000' UNION Drilling Line and a 9-16" x 6500' UNION Sand Line are in use on this well, which is being drilled by Blackburn and Blackburn for the Eastern Ohio Development Company (Benedum Trees) . . . The men, left to right, are: Oscar Blackburn, Contractor; F. A. Larimer, Jarecki Mfg. Co., Branch Manager; M. G. Brown; R. C. Hyde; F. A. Donaldson, Union Wire Rope Corp.; E. E. Blackburn, Contractor; and P. V. Kaine.

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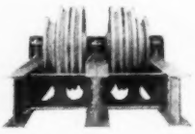

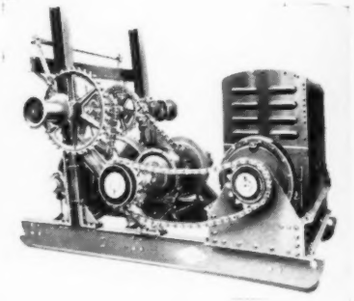

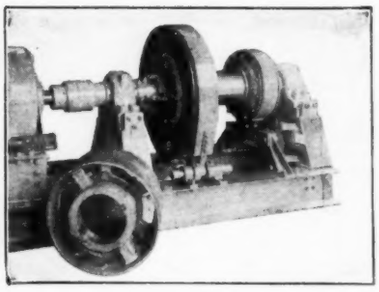

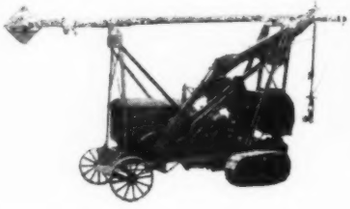

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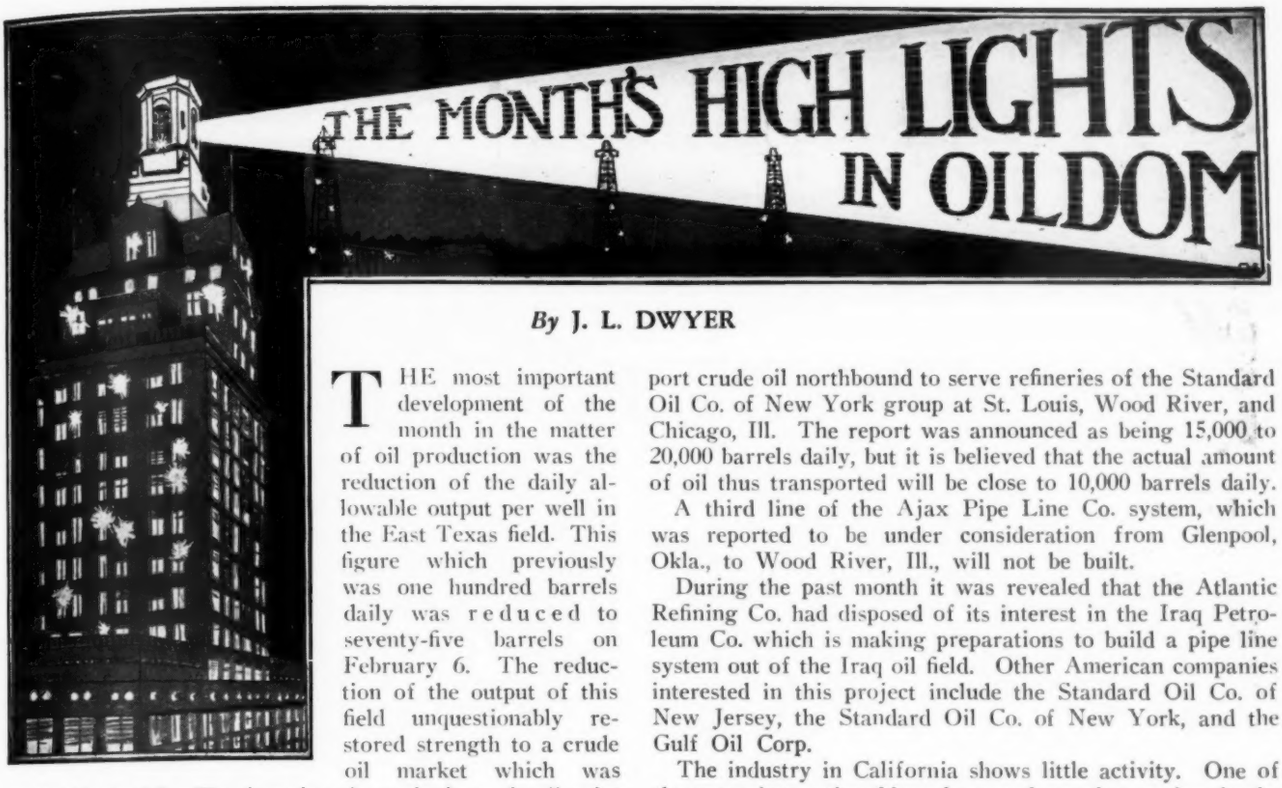


By **J. L. DWYER**

THE most important development of the month in the matter of oil production was the reduction of the daily allowable output per well in the East Texas field. This figure which previously was one hundred barrels daily was reduced to seventy-five barrels on February 6. The reduction of the output of this field unquestionably restored strength to a crude oil market which was noticeably "soft". The fact that the nation's crude oil price situation has continued in its present trend throughout the winter months indicates an exceptional situation. When the price of crude oil was raised last fall, gasoline was selling at the refinery for approximately five cents per gallon. Since that time, the price to the refiner has declined until early February showed many instances of gasoline bringing three cents per gallon (for the middle brackets). In spite of this factor, the price of crude oil remained unchanged.

Announcement was made early in February that the Magnolia Petroleum Co. had completed arrangements with the Prairie Pipe Line Co. whereby the latter concern will transport crude oil northbound to serve refineries of the Standard Oil Co. of New York group at St. Louis, Wood River, and Chicago, Ill. The report was announced as being 15,000 to 20,000 barrels daily, but it is believed that the actual amount of oil thus transported will be close to 10,000 barrels daily.

A third line of the Ajax Pipe Line Co. system, which was reported to be under consideration from Glenpool, Okla., to Wood River, Ill., will not be built.

During the past month it was revealed that the Atlantic Refining Co. had disposed of its interest in the Iraq Petroleum Co. which is making preparations to build a pipe line system out of the Iraq oil field. Other American companies interested in this project include the Standard Oil Co. of New Jersey, the Standard Oil Co. of New York, and the Gulf Oil Corp.

The industry in California shows little activity. One of the most interesting bits of news from that region is the report that the Geo. F. Getty Co., Inc., has acquired control of the Pacific Western Oil Co.

International standardization methods of testing petroleum products and lubricants is being sought by 21 industrial countries through the agency of the International Standards Association. Dr. R. P. Anderson of the A. P. I. staff has been named American representative.

Much interest is being displayed in the Mid-Year meeting of the American Petroleum Institute, which will be held at the Mayo Hotel, Tulsa, Okla., June 1, 2 and 3. This will be a combined meeting of all three branches of the Institute, production, refining and marketing.

• • •

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending January 23, 1932

(Figures in barrels of 42 gallons each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	410,400	64.8	4,891,000	7,746,000
Appalachian	91.8	84,900	61.8	1,463,000	1,395,000
Ind., Ill., Ky.	98.9	250,600	58.1	4,574,000	5,152,000
Okla., Kans., Mo.	89.6	222,400	51.1	3,351,000	3,826,000
Texas	91.3	523,000	68.3	8,497,000	10,789,000
Louisiana - Arkansas	98.9	157,300	68.2	1,250,000	4,166,000
Rocky Mountain	89.4	41,100	28.6	1,746,000	726,000
California	97.1	452,400	50.9	13,966,000	96,121,000
Total Wk. Jan. 23	95.2	2,142,100	58.4	39,738,000	129,921,000
Total Wk. Jan. 16	95.2	2,124,900	58.0	*39,208,000	130,330,000
Total Jan. 24, 1931	95.7	2,231,800	62.5	†40,365,000	132,052,000
The Texas and Louisiana Gulf Coastal figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	99.8	401,400	75.5	6,637,000	7,987,000
La. Gulf Coast	100.0	111,600	75.7	1,123,000	3,308,000

Daily Average Production

(Figures in Barrels)

	Jan. 30, 1932	Dec. 26, 1931	Jan. 24, 1931
Oklahoma	411,700	534,950	466,900
Kansas	97,900	105,550	107,300
Panhandle Texas	52,850	51,750	57,850
North Texas	49,350	54,350	62,700
West Central Texas	25,950	26,250	25,500
West Texas	173,750	175,600	249,850
East Central Texas	49,750	50,300	39,950
East Texas	332,750	316,000	4,650
Southwest Texas	52,100	55,200	77,800
North Louisiana	29,050	27,550	40,400
Arkansas	34,300	33,050	50,650
Coastal Texas	111,800	115,700	159,900
Coastal Louisiana	28,450	29,700	27,200
Eastern (not including Mich.)	106,600	108,250	99,500
Michigan	14,450	16,250	9,250
Wyoming	35,650	37,800	45,400
Montana	5,850	7,800	6,850
Colorado	3,650	4,000	4,500
New Mexico	37,000	43,250	39,250
California	508,600	499,600	535,200
Total	2,161,500	2,292,900	2,110,600

NOTE: Refer explanation California stocks figures.

*Revised downward in Indiana-Illinois area 352,000 barrels; in Oklahoma-Kansas district 93,000 barrels, and in Rocky Mountain area 200,000 barrels (total U. S. 645,000 barrels reflecting net change in figures received correcting report for week ending January 16).

†This figure is not entirely comparable with current stocks due to revisions made since original publication of this figure, for which revisions the basic information is not available by weeks. If it were possible to have made the revision, the new figure would reflect somewhat lower stocks.

COMPLETING EAST TEX

By K. C.

Welding the screen joint coupling before lowering into the hole.

WHEN a well in the East Texas field is brought in, present curtailment regulations require that it be produced at only a fraction of its possible normal rate of production daily. This restriction, while it may tend to enhance the long-term prospective return on the investment, lessens to a serious degree the near-term rate of revenue return and so compels the exercise of the utmost economy in the completion of wells.

Fortunately, the completion of wells in this field thrusts no particular difficulties in the path of the operator. The formations on the whole are comparatively easy to drill. The thickness of the pay sand throughout the field, and level of the water table in the pay sand on the west edge are known within reasonably close limits. These are underground conditions that, considered alone, leave some latitude of choice as to the method of completion. But this choice is likely to be greatly modified according to the course the curtailment program will take.

This combination of conditions apparently has had some influence on the methods adopted in the completion of wells and accounts for the variation in methods used.

It is general practice with many operators to set perforated liners in the producing sand. A 9-inch hole is carried to the top of the sand, where a string of 7-inch (A. P. I.) casing is set and cemented. After allowing the cement to set for 72 hours, the plug is drilled out, the sand penetrated with a 7-inch hole to the required depth and a 5 3/16-inch liner set. Sometimes a packer is used on top of the liner to keep out cavings.

There are some operators who drill a well of small diameter to the top of the sand, using a light portable-type rotary drilling outfit. These are the so-called "midget" wells. They are cased with strings of pipe as small as three inches in diameter. In drilling into the sand, 1½-inch flush joint drill pipe is used.

One "midget" well in the North Kilgore area was completed with a string of 3-inch (3½-inch O. D.) 8½-pound tubing landed at 3,539 feet and cemented to the surface. After the cement was placed a pressure of 1,000 pounds per square inch was maintained in the tubing for 12 hours. The well was completed with a three-inch hole in the sand. A small tapered string, ¾-inch diameter at bottom and 1½-inch diameter at top, was installed as a flow string. The reported total cost of completing this well, including gas separator and all surface connections to put the oil into the tanks, was $10,000. The exact penetration of this well in the producing sand was not ascertained. Apparently the owners of the well are satisfied that the diameter of hole and penetration in the sand are large enough to enable the well to produce its quota of oil from the pool. They assume that with the small flow string it will be possible to flow the total ultimate production of the well. It will be interesting to follow the history of this well and compare it with other wells in the field after a year or more.

Several operators in the field are completing their wells to the sand with large casing, landing and cementing it in the usual manner, but in drilling out the plug and drilling into the sand, a string of 2½-inch tubing with a fish-tail bit on bottom is used as a drill. By keeping a close watch on the weight indicator and holding the weight off the bit, trouble at the tubing couplings is obviated. When the well is drilled in, the tubing is lifted several feet off bottom and, after being washed or swabbed in, is produced through the tubing. The oil from the well enters the tubing through the holes in the fish-tail bit.

Adapting tubing to this type of service is an expedient that has been resorted to in an attempt to lower well completion costs. Those who have completed wells in this manner claim that, besides obviating the necessity of using small drill pipe, it expedites the completion of the well and decreases the hazard contingent on the well coming in unexpectedly, as drilling in is usually done through a tubing control head. There is danger, however, of setting up excessive torsional stresses that might cause serious injury to threads and couplings. It should be borne in mind that in using a string of tubing as a drill stem, the tubing is being subjected to a type of service for which it was never intended. Extreme care and good judgment apparently have been used in the employment of tubing in this manner, as thus far no serious trouble has been observed in the field that could be construed as condemning the practice, a tribute in itself to the uniform quality of tubing in use.

Another method of completing wells followed by several companies in the field is that wherein a perforated liner or screen the full diameter of the casing string is employed. Setting the screen or liner and cementing the casing are accomplished in one operation. To do this a tool known as a Full Hole Cementer is used.

WELLS IN THE AS FIELD

SCLATER]

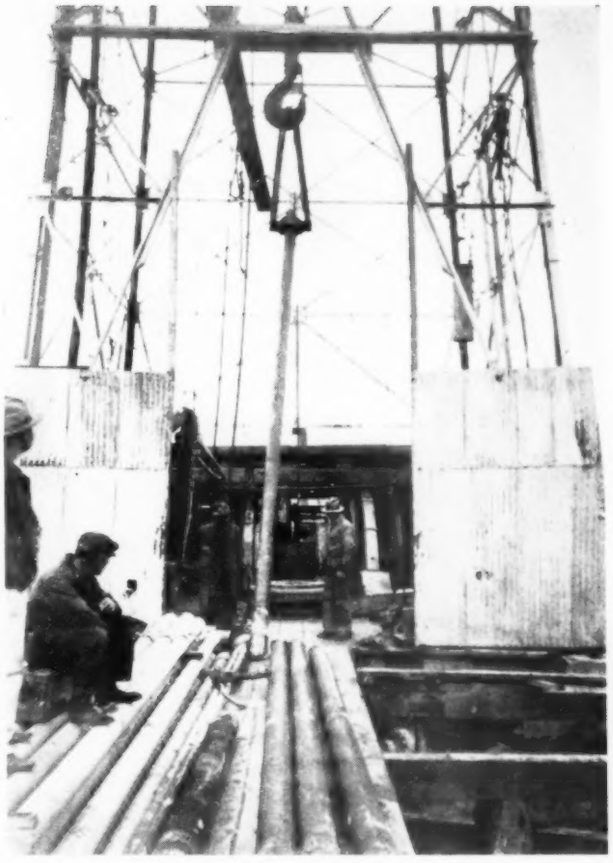
Instead of landing the casing above the sand and reducing the diameter of the hole at that point, the full size hole is carried on into the sand to the required depth. The casing is then run with the liner and cementing tool on bottom.

On the accompanying photographs are shown screen pipe and Full Hole Cementer being run in a well in the East Texas field. A cement float shoe is screwed into the bottom joint of screen pipe. Above the three joints of screen pipe the cementing tool is inserted. It will be noted in the picture that on the tool used on this well a boot-leg packer was used; its use, however, is not essential and is optional with the operator. The casing is screwed into the top of the cementing tool. Before being run in the well all screen pipe couplings, the float shoe coupling and the cementing tool couplings are welded. In this well, 7-inch A. P. I. casing and 7-inch 40-mesh slotted screen pipe were used.

The latest type of cementing tool, which is a modification of that being shown run in the well in the accompanying photograph, contains an inner sleeve about 18 inches long, to the lower end of which is attached a back pressure valve opening downward. The valve and sleeve when lowered into the well rest on four small pins that project from the inside wall of the tool. In this position, the upper part of the sleeve covers four holes or cement outlets about an inch in diameter, drilled through the outer sleeve of the tool. As the lower wooden plug, ahead of the cement in the casing, strikes the back pressure valve it shears the small pins on which the sleeve and valve are resting and the sleeve drops and uncovers the cement outlets as both valve and sleeve are forced down to rest on the end of the top joint of screen pipe. As the cement outlets open, the cement is allowed to pass on outside the casing to its final resting place. As the second wooden plug on top of the cement reaches the bottom plug it shuts off circulation and the operation of setting the screen and cementing the casing is completed.

After the cement is allowed to set the usual time (72 hours) the plugs are drilled out and the well brought in. In drilling out the plugs, a short diamond-point bit on the bottom of a string of 2½-inch 6½-pound upset tubing is used. The greatest care is exercised in this operation to keep only the minimum weight necessary on the bit. When the plugs are drilled out the tubing is suspended about eight feet off bottom and the well washed in and/or if necessary, swabbed through the tubing. The well is allowed to produce through the two small holes in the diamond-point bit into the tubing.

An improvement in this method of completing wells with a large diameter hole and full hole screen or liner has recently been introduced. It is the use of a special cement lining, about half-inch thick, that is so applied to the inner surfaces of the screen that it covers all the perforations or slots while running in the hole. By its use it will be possible to obtain a more positive and thorough job of removing mud, silt and cuttings from the space between the



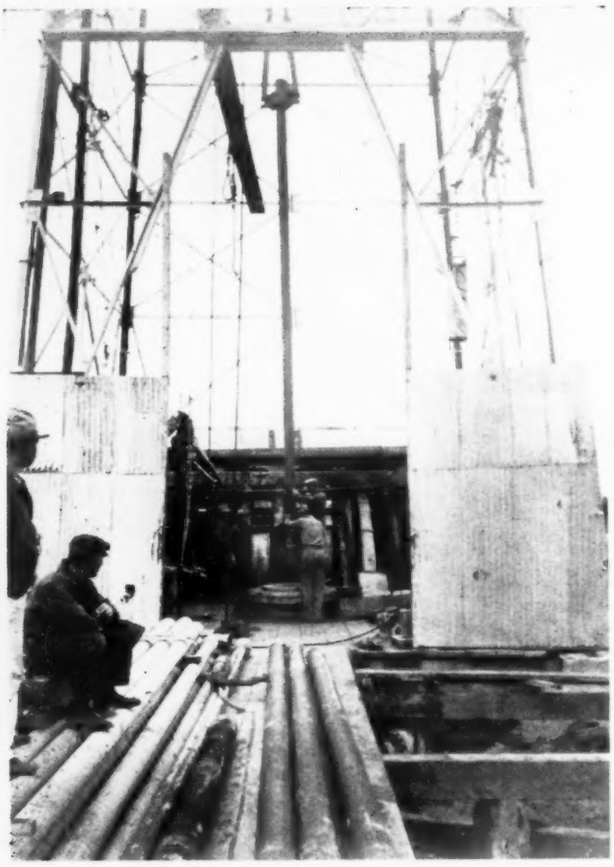
Hauling in the bottom joint of 7-inch O. D. (A. P. I.) screen pipe. It has a cement float shoe on bottom.

outside of the screen and the sand face than has been possible by any other means heretofore. This washing is done before the cement is placed. The thorough washing that the face of the sand undergoes by this means greatly facilitates the operation of bringing the well in after the plugs and cement lining on the interior of the screen are drilled out. A special composition paper between the cement lining and the screen prevents the cement making a permanent bond with the inside surface of the screen and insures its easy and complete removal when drilled out.

Several advantages are claimed for the completion of wells in this manner. A large diameter hole drilled into the producing sand gives a larger superficial area of sand exposed to the well, thus permitting a freer flow of oil into the well. The part that hole diameter plays in the producing life of the well will be discussed presently. If it is desired to carry the well to a greater depth at a later date, the screen or liner being the full size of the casing string makes a ripping job unnecessary. A greater core recovery is possible when drilling into the sand with a full size hole. As the larger diameter hole in the sand gives a greater superficial area for oil flow into the well the penetration need not be so great, and the hazard of drilling into bottom water is correspondingly reduced.

With the restricted producing conditions that now obtain in the East Texas field, the value of a hole of large diameter in the producing sand is discounted by many. It is contended that there is no advantage in drilling a large diameter hole so long as wells are prorated. This reasoning has no doubt led many operators to adopt the practice of drilling "midget" wells. Whether such reasoning is sound is doubted.

A small diameter well in the sand may produce as much



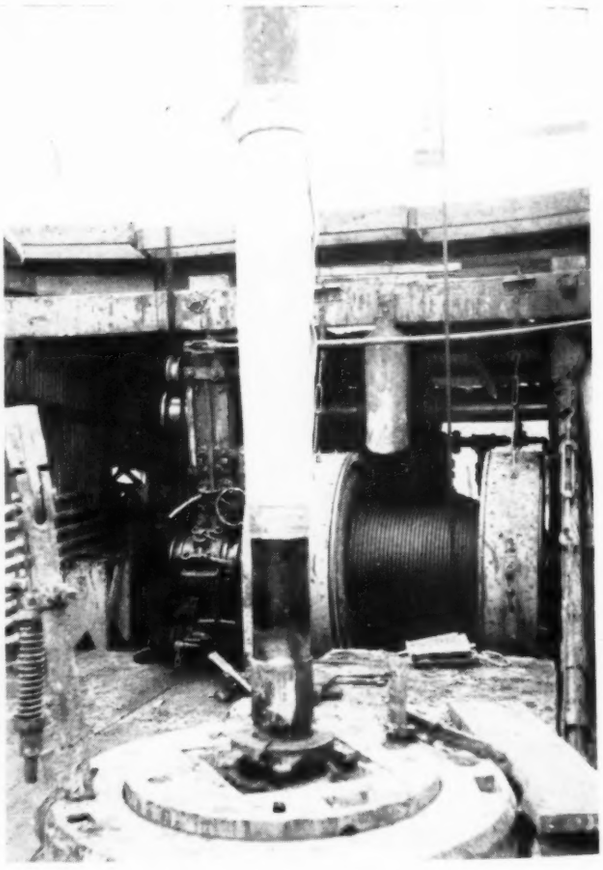
Ready to lower the first joint of screen pipe into the hole.

today—and probably for some months to come—as a well of larger diameter in the sand. But when the rock pressure diminishes to the point that wells cease to flow naturally and have to be pumped, the economic life of the small wells in the field, that is, the wells of small diameter in the sand, are most likely to be cut short. Even were it possible to flow them at a very slow rate, paraffin troubles will have to be reckoned with, in which case the small diameter wells may be at a great disadvantage. Also in the later life of the field when the flush production has gone off, the superficial area of the producing sand exposed in a well will be more a measure of what that well is capable of producing than it is at present. Future crude price changes may also enter to prolong the economic life of the field, in which case the wells of large diameter would stand to reap a greater ultimate return than the wells of small diameter. The wisdom of the procedure of drilling wells of small diameter into the producing sand is therefore a matter of doubt at the present time.

Another factor to be considered is one that concerns wells on the west edge of the field. It is water encroachment. The rate of water encroachment will determine largely the economic life of many wells close to the water encroachment line. If a well is likely to be overtaken by water before the restrictions on production are removed, the drilling of a "midget" well might be justified. This would be true if the wells were able to produce their allowable up until they went to water. While the diameter of the hole in the producing sand would have no effect on the rate of water encroachment it might, if too small, have an adverse effect on the continuous operation of the well, especially if a large volume of water had to be handled to obtain the oil. Installation of ample pumping equipment to cope with such a condition might not be feasible.

In considering well completion in the East Texas field, there is a great diversity of opinion regarding the use of screens or liners. Evidence of this is the fact that several companies do not use screens or liners of any kind producing their wells "barefoot". Some use special slotted screen, while others use ordinary perforated pipe. No better way of eliminating or minimizing sand trouble can be found than by curtailing the rate of flow from the well. Economic reasons usually will not allow taking such a drastic step as curtailing the well's production. The low per well allowable in the East Texas field automatically removes from the picture the possibility of serious sand trouble in wells. This, in large part, may account for the apathy displayed by many operators toward the use of screens or liners in wells.

As mentioned at the outset of this article, the curtailment of production in the East Texas field has been a potent factor influencing the method of completion of wells in the field to date. With 3,000 or more wells still to be drilled, what trend from present practice completion methods will take depends as much on the extraneous economic factor of production curtailment as on a consideration of the intrinsic future benefits that will accrue to the producing life of the wells themselves.



The R. S. M. Full Hole Cementer just before lowering into the hole.

Motor-driven centrifugal pump station in East Texas.

PARAFFIN PROBLEMS *in East Texas* High Pressure Lines

By J. H. DAMERON

CRUDE oil transporting companies operating main and gathering lines in the East Texas area are encountering a paraffin problem in handling the oil that gives indication of developing into one as troublesome, relatively, as the field is expansive. In many respects the pumping characteristics of the oil are diametrically opposite to those of other paraffin crudes. Many companies have experienced far more trouble with their high pressure main lines than with their gravity lines. So rapid is the deposition of paraffin in some of the high pressure lines that scrapers are run through the main lines every four or five days. In such lines it is not uncommon to find the line operating five or six per cent under capacity four or five days after being cleaned with a scraper.

The north end of the field appears to give the greatest amount of trouble and lines operating with this crude offer the most striking examples of the cost and loss of revenue occasioned by paraffin restricting flow. Other parts of the field do not escape such objections, however, and as the area grows older no part of the field is expected to be free of paraffin troubles.

One of the first trunk lines out of the field is an 8-inch carrier that has been in operation about a year. The line is 60 miles long and is operated with two main line stations. It gets most of its crude supply from the north end of the field and during its period of service it has delivered its full capacity only a few times. When running to capacity the line delivers slightly more than 30,500 barrels at 900 pounds. The following table is an example showing the rapidity with which the paraffin chokes down the flow of crude in a short period. It shows the runs for a five-day period following cleaning the line with a scraper:

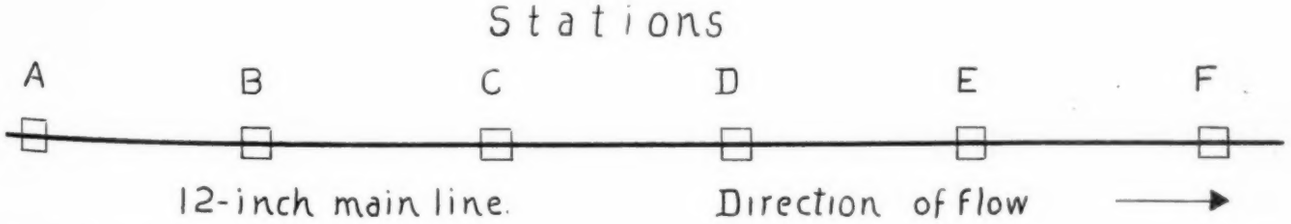
First day	30,500 bbls. at 900 pounds pressure
Second day	30,000 bbls. at 900 pounds pressure
Third day	29,760 bbls. at 900 pounds pressure
Fourth day	29,200 bbls. at 900 pounds pressure
Fifth day	28,950 bbls. at 900 pounds pressure

The deliveries were made the early part of last fall when atmospheric temperatures were still high. Since that time the line's deliveries have been curtailed and it is not running to capacity. During the periods when it was desired to maintain the line's capacity at a maximum scrapers were put through the line every four or five days to keep it operating between 30,500 and 29,900 barrels.

Each time the scraper was run approximately 50 pounds of paraffin was removed at the line's terminal. This was removed partly as a mass about the consistency of jelly, while the remainder and greater portion was a soft wax.

East Texas crude starts congealing at about 53 degrees F. when exposed to the atmosphere. A sample in a bucket will congeal at the top and become difficult to pour, but when agitated it will readily flow. In the pressure lines its congealing point apparently is lower because oil slightly below that temperature was pumped with no more trouble than ordinarily experienced during summer temperatures. East Texas, however, has not to date had low temperatures existing for any appreciable length of time.

Paraffin in this line, as in several others, deposits fairly uniformly on the inside surface of the pipe. Where lines have been cut the deposit appeared to be a few hundredths



of an inch thick, adhering to the pipe fairly tight and about the consistency of jelly. It was easily scraped out. A first glance led many to believe it contained considerable fine sand or dirt because of its granular appearance not unlike fine sand sprinkled on fresh paint. When heated or rubbed in the palms of hands no indication of dirt or sand was found.

How much of this paraffin actually is in the line is difficult to ascertain. Engineers working on the problem estimate a considerable part of it cut away from the inside walls of the pipe goes on ahead of the scrapers with part of the jelly-like substance going back into solution in the oil.

The gathering system supplying this trunk line has its share of paraffin troubles. So much in fact that the part of the gathering system operated with pressure was designed with a check valve that would permit the passage of a scraper.

On an 8-inch field line that had been in service two months a scraper was run and stopped after traveling 1½ miles. At that point about 50 pounds of paraffin was removed and the scraper had to be taken out in two sections. On the second run of the scraper all the paraffin was permitted to go into two 1,500-barrel tanks which had been in service about eight months. In one tank 10 inches of paraffin was in the bottom and six inches was found in the other.

Partially cleaned scrapers with sticky wax clinging to the moving parts.

In this same system a short 4-inch gravity line was connected to a tank battery. After running about 10,000 barrels the line was cut. Paraffin had choked the line down until only about a three-quarter-inch opening remained. On another gravity line only one 500-barrel run went through the line freely and the second 500-barrel run wouldn't go through in 24 hours.

When about four miles of 8-inch field line was cleaned one company was forced to shut down its field station intermittently for two days. Shortly after the scraper was started through the line the pump had to be shut down while a gummy mass of paraffin was removed from the suction valves. This condition prevailed at lengthening intervals for two days while the scraper pushed through.

On a main line where centrifugal pumps were in service at a booster station the first run of the scraper through the line shut down the pumps. The two pumps are hooked up in series and operated at about 3600 r.p.m. When the scraper was several miles away from the station the trouble started showing up and in a short while the paraffin collected on the impellers in sufficient quantity to cause the units to be shut down. It was necessary to remove the case and clean the impellers before the booster could be put back on the line.

Paraffin problems on a 200-mile 12-inch line running to the Gulf Coast have been almost as bad as the example of the 8-inch artery. This line was placed in service about the middle of October and with all stations operating to capacity run. Later it was several thousand barrels under capacity when the line was delivering around 50,000 barrels daily at 750 pounds pressure.

The line had no trouble getting capacity through from the initial station down to the next station, but in between were field stations delivering into the main line. From the second station or station C on down to station F as shown by sketch deliveries dropped off steadily but at a slow rate.

A scraper was started through the line at station C on January 1, and removed at station E. When it was removed from the scraper trap about 15 pounds of paraffin came out ahead of it. That which adhered to the scraper was not easily removed with cleansing agents and was best removed by dipping the scraper in boiling water. The scraper was put back in the line at station E and run to station F where less than 10 pounds was removed from the trap. The piping layout at this point readily permits the bulk of any paraffin ahead of the scrapers to go on into any one of the several tanks at this station and it is believed that a considerable amount went into the tanks, although they have not been sampled with a thief.

Following the cleaning of the line with a scraper the runs increased approximately 4,000 barrels. During this period the average temperature difference between stations C and F was between 8 and 10 degrees with F showing the higher temperature. The oil was handled during average fall weather and the line crosses more streams between E and F than between C and E.

The scraper was started through the line again about the middle of the month and about 10 pounds of paraffin was removed at station E and half as much at station F. The runs following this were increased about 2,000 barrels daily, but in the meantime the line dropped down 1,000 barrels in deliveries between stations C and F during the periods between cleaning. The net result of the two cleanings is figured to have increased the deliveries of oil through the line to the extent of 5,000 barrels daily and, of course, increased the revenue.

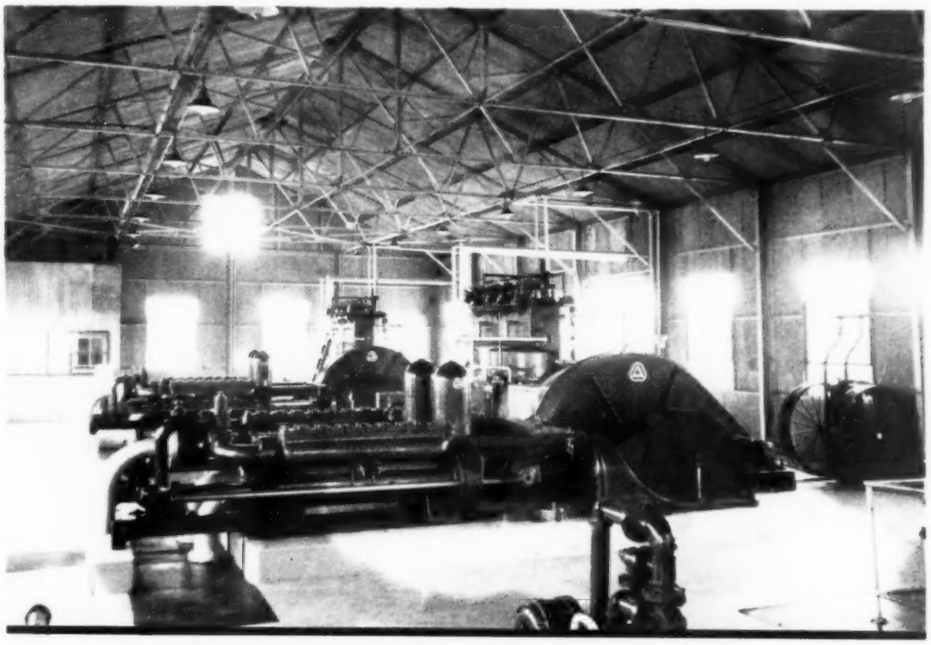
In many respects the characteristics of the East Texas

crude coincide with those of Darst Creek. On one of the main lines out of that area a scraper had to be run between the first two stations every other day in order to pump between 360 and 440 barrels per hour at pressures ranging from 700 to 750 pounds. The two stations are 40 miles apart. Each trip of the scraper removed 6 to 8 pounds of thick, gummy, granular paraffin. This deposit was not heavy, but its granular appearance led many pipe liners to believe it caused a loss in capacity more to increased friction rather than to reduction in cross section area.

On this same line the initial storage tanks showed a greater accumulation of paraffin than succeeding tanks on down the line. Each succeeding storage point away from the field showed about half as much paraffin in tank bottoms as the station tanks behind it. When the line reached its terminal the storage there had a negligible amount of paraffin in the tanks.

The gathering lines for these systems did not show paraffin. When it was discovered paraffin was cutting down the capacity of the high pressure lines it was decided to inspect the gravity lines, but they showed only slight traces of it. Over a period of several months no trouble was experienced in the gravity systems.

When the oil was shipped in tank cars there was usually a heavy deposition of paraffin in the bottoms which was removed when the tanks were emptied or returned to the field racks to be filled.



Interior view of Arkansas Pipe Line Co. main line station.

Like East Texas crude in numerous instances, the greatest trouble with Darst Creek crude was experienced in the pressure lines. Other companies than those whose lines are described report most of their paraffin trouble is in the high pressure lines. For the most part East Texas transporters have not experienced a great deal of trouble with paraffin in their gathering lines. But these lines have not been inspected because it has been possible to move the required amount of oil through them. Should these same lines be called upon to handle more crude many believe a now existing but unnoticed source of trouble would be found. It is significant to note, however, that the more recently installed gathering systems have check valves, where they are required, that will permit passage of scrapers.

Chemicals are used quite extensively in an effort to open up lines in the gathering systems. In numerous cases this method is successful. Certain leases are known to produce oil that gives an unusual amount of trouble. When the batteries are turned into the line it is common practice for some to pour one-half to one gallon of chemical in the tanks.

The condition of the large storage tanks in the field and at stations is not generally known, but many are of the opinion that by spring these tanks will show considerable paraffin. In several instances the suction lines leading to the large tanks have been opened and are clean. But discharge lines on the opposite side of the station have been opened and a thin coating of granular paraffin found uniformly around the inside circumference of the pipe.

So far about the only remedial steps taken to keep the main lines open is the frequent use of scrapers. This method, along with chemicals, is used to keep the gathering lines open. It sometimes happens that the scrapers will pile up such a mass of paraffin ahead of them that the line has to be cut. This happened on an 8-inch main line and eight joints of solid paraffin was removed, by cutting it out of the line.

Engineers giving their study to the problem are loath to express an opinion as to why the oil under pressure gives more trouble. East Texas crude, to a great extent, carries considerable gas in solution. This is evidenced by the early troubles with vapor lock in pumps and by the frequent loss of from two to four inches in a tank after it has been filled.

Some are of the opinion that a combination of pressure and turbulent flow may cause the gas to come out of solution, accelerating precipitation of paraffin which clings to the walls of the pipe. Temperature, it is agreed, has considerable bearing on the problem although a great deal of the trouble outlined developed during the warmer months. The opinion is expressed and seems to be supported by experience in the field that the higher the viscosity of the oil, either from low temperature or gasoline constituents removed from solution with the gas, tends to hold the paraffin in suspension, while at higher temperatures and with all gasoline constituents of the gas in solution the viscosity is lowered and does not retard but rather promotes precipitation of paraffin.

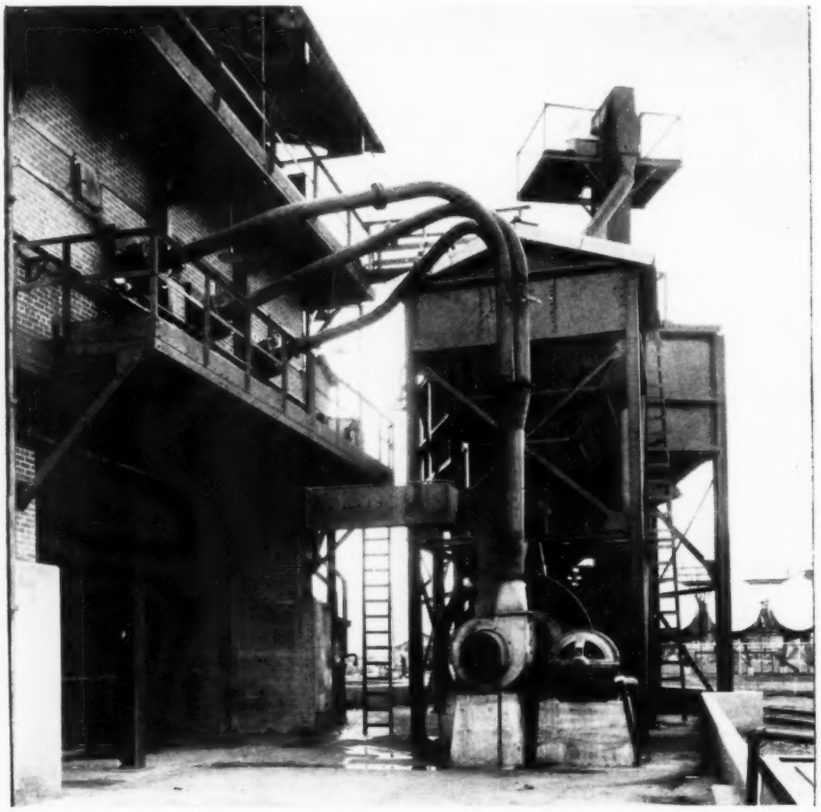
Pumping machinery in the stations is also affected by the paraffin crude, especially the Diesel engine-powered stations. Where the latter named machinery is used most of the trouble is with the fuel lines. When the crude congeals in the working tanks and water is pocketed it sometimes happens that a slug of water reaches the engine and shuts down the unit. In most instances machinists plan to overcome the trouble from this source with heating coils. One company is using a combination of heat and pressure on its fuel lines, drawing the fuel direct from the discharge manifold, reducing the pressure through a small orifice and heating it before it reaches the fuel pump.

Petroleum Coke *and* Asphalt

By F. R. STALEY

PETROLEUM coke is produced as a refinery by-product from a coking or a cracking process. In recent years enormous piles of it have accumulated at some of the large refineries. Due to intelligent sales effort however, it is becoming generally known that this is the most efficient and convenient solid fuel for either domestic or industrial use, and at some plants the sales now exceed production during the winter season.

The use of pulverized coke as a refinery fuel is rapidly increasing. A report of the U. S. Bureau of Mines[1] states that refiners have always known that petroleum coke was a superior material from the standpoint of heat units and ash content, but its use as a fuel at refineries has been retarded because of the lack of suitable firing equipment. However, indications point to considerable progress in the design of equipment to pulverize and feed coke to boilers and stills during 1930. The consumption of coke as refinery fuel rose from 488,000 short tons in 1929 to 580,000 short tons in 1930, a gain of 19 per cent. On the other hand, the total production of coke in 1930 was only six per cent above 1929. Allowing for the appreciable quantities of coke sold for domestic or industrial purposes in 1930, there remains a material quantity of coke, particularly cracking-still coke, that was dumped on the ground and not considered as part of the stock inventory. It is probable that some of this waste coke will be reclaimed and used as refinery fuel in the future. There will always be a considerable quantity that is produced in amounts too small to justify the installation of special equipment to burn it. The large refineries that are located in the Texas Gulf Coast district produce great amounts of coke and, in the absence of a sizeable domestic market, burn the most of the output as refinery fuel. For example, the use as fuel in that district in 1930 totaled 280,000 short tons, the quivalent of 72 per cent of the output of that district and of 48 per cent of the total used as refinery fuel in the United States in 1930.



A pulverized coke installation on a distillation unit.
—Courtesy Foster Wheeler Corp.

Petroleum coke has a heating value of approximately 15,000 B.t.u. per pound. It tests about 95 per cent fixed carbon and less than two per cent ash.

Some refineries have installed conveying and screening equipment in order to grade the coke according to size to meet market requirements. The fines up to one and one-quarter inches in diameter is used by industrial plants. The egg and the lump sizes to four inches in diameter are used for domestic fuel. For this purpose it is superior to the best grades of anthracite coal. It has the advantages of cleanliness, very little ashes, and high heating value. Very little draft is required to burn it in a household furnace, and it is advisable to start it burning with a small bed of ashes in the grate.

Coke Stills

Coke stills have been used in refinery practice for many years. The shell-type still is used for this purpose. Residuum from asphalt base crudes, slop cuts, wax tailings, and cracking units are charged to these stills. They are fired to distill off first any volatile hydrocarbons that are present, and finally as the temperature is increased, cracking and refining takes place, with the formation of fixed carbon or coke which remains in the still. The overhead products are collected, and fractionated into fixed gas, gasoline distillate, and cracking stock. This gasoline has a high octane number or knock rating.

The Atlantic process[2] is described as follows: the charge is preheated in a pipe still to 725 degrees F. It is then fed to the coke stills. There are 16 of these in a battery. Two of them are charged at a time. The vapors from the stills are condensed and transferred to the cracking plant; they represent about 85 per cent of the charge. The charge is about 700 barrels. It requires about two and three-quarter hours to feed the still. The temperature is maintained at 650 degrees F. and gradually increased to 800 degrees F. during a ten-hour period after the charging is

finished. This temperature is maintained until the completion of the running time, usually about 15 hours.

When the coking is completed the still is allowed one hour to relieve pressure, then exhaust steam is injected into the still for two hours to drive out all traces of vapor before the coke is removed.

In each still is placed about twenty steel frames before charging. They are all linked together. Coke is formed in and around these frames to a depth of several feet. After the head is removed from the still a cable is attached to the coke pans and they are pulled out of the still by means of a winch. The remaining coke in the still is removed by laborers. The coke is sprayed with water to cool it, loaded into dump cars, and hauled to storage.

The Knowles Process

The Knowles process is owned by the Brassert-Tidewater Development Company. A number of refiners have installed this process for coking heavy residuum oil from cracking units. Briefly, it is carried on as follows:

The charge is preheated in a pipe still to 750 or 800 degrees F. and then fed to a battery of coking ovens. The floor in each of these is constructed of refractory blocks. This is highly heated during the charging period. The charge is cracked into coke and vapors. When the coke layer is about eight or ten inches thick, charging is discontinued and the firing continued for several hours to drive off all volatile constituents from the coke. Live steam is turned into the oven during this period. The coke is pushed out of the oven by a ram into a hopper car and quenched with water. This procedure is similar to by-product coke oven practice. The yield of coke depends upon the nature of the charging stock.

The vapors from the coke ovens are collected and fractionated into fixed gas, gasoline, and gas oil. On account of the high temperatures involved the hydrocarbons formed in this process show very high knock ratings.

Dunstan, Hauge, and Wheeler[3] studied the pyrolysis of the paraffin hydrocarbons for the production of aromatics at atmospheric pressure. They show that in the temperature range 800-900 degrees F. with the paraffins ethane to pentane a conversion into aromatic liquids corresponding to from 22 to 27 per cent by weight is obtained. Approximately 50 per cent of the total liquid hydrocarbons produced boils below 170 degrees F., the chief constituent being benzene.

As with the paraffin hydrocarbons, it was found that, following the primary reactions brought about by heat-treatment, secondary reactions occur which lead to the production of aromatic hydrocarbons. This stage in the pyrolysis of the olefines closely resembles that observed with the paraffin hydrocarbons.

It will be observed that over the temperature range 700-850 degrees the conversion corresponds to 36-40 per cent by weight of the olefine passed, and the liquid produced contains 50-60 per cent distilling below 170 degrees. The aromatic hydrocarbons resembled the liquid hydrocarbons from the paraffins.

Coke from Cracking Units

A recent article in the Shell-Globe[4] describes the clean-out operation from the Dubbs Cracking Units at their East Chicago refinery. Coke accumulates in the reaction chambers during the cracking process. When these are full the unit is shut down for cleaning. About 165 tons of coke is removed from the chambers. It forms a solid mass in the chambers, and broken out by withdrawing heavy steel cables which are coiled in place in the chambers before starting the run.

Asphalt Manufacture

Some refineries find it more profitable to produce asphalt rather than coke from their asphalt or mixed base crude.

A number of vacuum fractionating units have been installed to handle cracking plant residuum. The flow sheet shows a unit charging cracked fuel oil of 1.02 specific gravity, Furol viscosity 2,000 to 3,000 seconds at 122 degrees F., flash point 400 degrees F. and one per cent B. S. It yields 30 per cent cracking stock, and 70 per cent asphalt of 153 degrees F. melting point.

An interesting two-stage asphalt plant recently started operation. It was built to run heavy Mexican crude or fuel oil, reduced Venezuelan crude or Cross residuum from Luling crude. The products recovered being naphtha, gas oil, fuel oil and asphalt having a 40 to 50 penetration at 77 degrees F.

The flexibility of the unit is such that it can run Mid-Continent crude to a 25 per cent fuel oil bottoms when so desired. The charge is pumped through heat exchangers to the atmospheric still where it is vaporized before being delivered to the flash chamber of the atmospheric tower. The lighter products including light gas oils are taken from the atmospheric tower and the residue is further heated in the vacuum tube still. From there it is delivered to the vacuum bubble tower, where the balance of the desired products are recovered.

Exhaust steam from the pumps is superheated in the stills and is used as process steam in the fractionating towers. Process steam from the vacuum tower is removed by a barometric condenser and the non-condensible gases are expelled by steam jet air pumps.

When operating for the manufacture of asphalt, the heat exchange equipment will preheat the charge to a temperature of 400 degrees F. and when fractionating Mid-Continent crude, the charge will be heated to a temperature of 320 degrees F.

Combined Vacuum Condenser-Receiver

A recent development introduced by a large engineering company is the combined vacuum condenser-receiver. The unit consists of a series of horizontal vacuum condensers or vapor heat exchangers built into a vertical cylindrical steel shell, the lower end of which serves as a condensate receiver. The vertical shell also serves as structural support for the unit, which is completely assembled in the factory.

A barometric condenser for condensing out process steam is often furnished with the unit and is mounted at the top of it, the total height being so gauged as to allow the necessary elevation for the barometric leg. Non-condensible gases are discharged from the top of the unit by means of steam jet vacuum pumps.

By virtue of complete fabrication, sealing of joints and testing under vacuum in the factory, the assembled unit is delivered to the customer absolutely tight throughout and ready for operation.

Condenser tube bundles are of the floating head type and are removable.

When a part of the condensate is being used for refluxing, a liquid level controller is installed in the tank and operates to maintain the level of the condensate between fixed limits by controlling the draw-off.

One of these units is being installed in a Kansas refinery to operate in connection with a cracking unit. It will produce marketable asphalt from the cracked residue.

REFERENCES

[1] U. S. Bureau of Mines, R I 3145.
[2] Atlantic S O S, October, 1931.
[3] Heat Treatment of Hydrocarbons, Jour. Soc. Chem. Ind., August 21, 1931.
[4] Shell Globe, November-December, 1931.
[5] Heat Engineering, October, 1931.

The DEVELOPMENT *and* APPLICATION *of*

THE trend of modern industry is toward greater efficiency and constant improvement. Competition demands that factories produce more goods, at ever decreasing costs. In order to accomplish these results each piece of apparatus must be kept up-to-date, replacing those of obsolete design, and the evolution of transmission equipment has played no small part in this program.

While V-belt drives are strictly modern in design and application, they are an outgrowth of the old manila rope drives which first came into use around the middle of the nineteenth century. At that time power was developed by means of large water wheels, or steam engines, and transmitted by these multiple manila ropes to line shafts extending through the factory, to which the numerous small machines were belted. There were two systems of rope drives in use at that time: the English system, composed of a number of individual strands of rope, applied just as the V-belts are used today; and the American system, consisting of one continuous piece of rope, running back and forth between the various sheaves. An idler pulley, adjusted with a weight, is used in the latter system to maintain the proper tension in the ropes.

Rope drives were believed to be an improvement over big flat belt drives for transmitting power from the big steam engine or water wheels throughout an entire plant, but the advent of the electric motor individually applied to machinery brought about their obsolescence. The sheaves required were too large to fit in with modern and compact plant design, and other factors such as stretch, danger from breaking ropes, etc., helped to make such drives practically obsolete.

Early in the twentieth century the forerunner of the modern multiple V-belt drive appeared, using leather belts. These proved rather unsatisfactory because of the stretch of leather under such conditions, and also because of the fact that a smaller angle between the sides was used, resulting in considerable belt distortion. Several machinery manufacturers were among the early users of this drive, but they practically all abandoned it before long.

It was during the world war, and immediately thereafter that the modern rubber and fabric V-belt first made its appearance, being first used to drive automobile fans. Certain manufacturers perfected these products and secured patents to cover these exclusive features.

One large manufacturer was the first to make any big forward strides in the commercial application of multiple V-belt drives. At about nineteen twenty-three this company first began to carry on experiments with such drives, getting into this problem because of the demand in the textile mills of the Southeast for a means of power transmission which would be smooth, and still positive and compact.

Spinning frames are very smooth running after they get under way, but the starting process involves a considerable amount of torque, due to the many friction points in such frames. Chain drives were being used to a big extent on individually driven frames, and the backlash present in them caused a great deal of breakage of the delicate threads. This cut down the production of the mill considerably. There were various other objections to chains and other types of individual drives, also.

This large manufacturer met with fair success as far as the operation of the first drives was concerned. They first experimented with pure cotton ropes, but were unable to find one that would stand up for any period of time, even though they went to the extent of importing some cotton from Belgium for the purpose. Finally, a number of automobile fan belts were used, and they immediately found that a big improvement had been effected.

As a result of this experiment the present high quality commercial belt was developed. From this beginning, the application of V-belt drives has spread to practically every industry, until today it is estimated that between two hundred and three hundred thousand drives are in service.

V-belts cannot be considered a panacea for every belting trouble, nor a solution for every transmission problem, but they have a definite field of application in which they excel, and many outstanding advantages, which might be enumerated as:

(1) Quietness.

(2) Freedom from vibration.

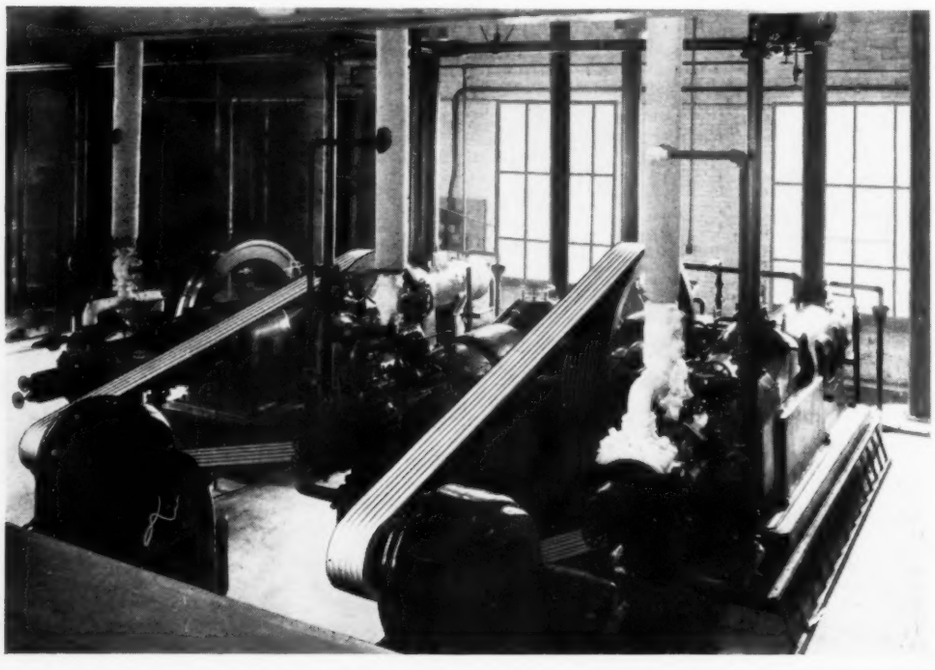
(3) Cleanliness.

(4) Reliability (because of the multiplicity of strands).

(5) No lubrication or any dressing required.

Since V-belts are operated rather loosely, contact between belts and sheaves being in the grooves, and not on the surface, as in the case of flat belts, bearing pressures are greatly relieved, resulting in economies in maintenance and expense in machine bearings.

Exceedingly short centers, between driving and driven units may be used, without loss in the efficiency of the transmission. This results in lower cost of transmission equip-

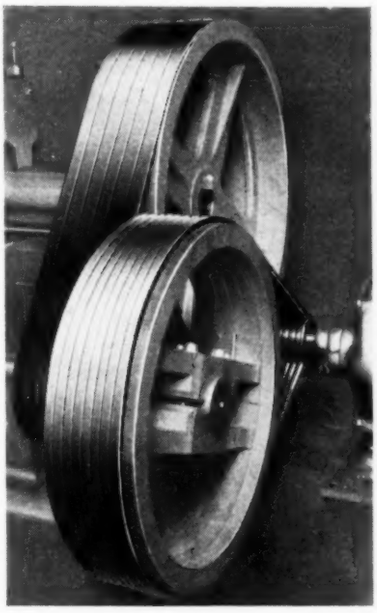


Motor Driven Refrigeration Machines in a Texas Refinery.

of "V" BELT DRIVES

By T. D. WILLIAMSON

ment, as well as a material saving in floor space. It is, of course, essential that the drive be properly selected as to speed ratio, horsepower, capacity, and sheave centers, in order that entirely satisfactory results may be secured. Also, the first cost of the V-belts selected is not the most important factor to consider, since the use of a quality belt should, and usually will, result in a lower cost per unit hour of service. The general design of all makes of V-belt drives are based upon similar engineering principles, hence they are all interchangeable, both as to sheaves and also belts. The angles of the "V" cut in the sheaves are the same for all manufacturers' products, and the lengths of the various sizes of belts have also been standardized. Thus if replacement belts are needed, any desirable make may be selected, regardless of the manufacturer of the original equipment. The application of V-belt drives enables the use of high-speed motors, thus adding several points of advantage to this type of transmission. The mechanical efficiency of V-belt drives is approximately 99 per cent, and there is practically no slippage, the driven speed being almost the same as the driving speed, the difference being in the "creepage" of the belt on the sheave.



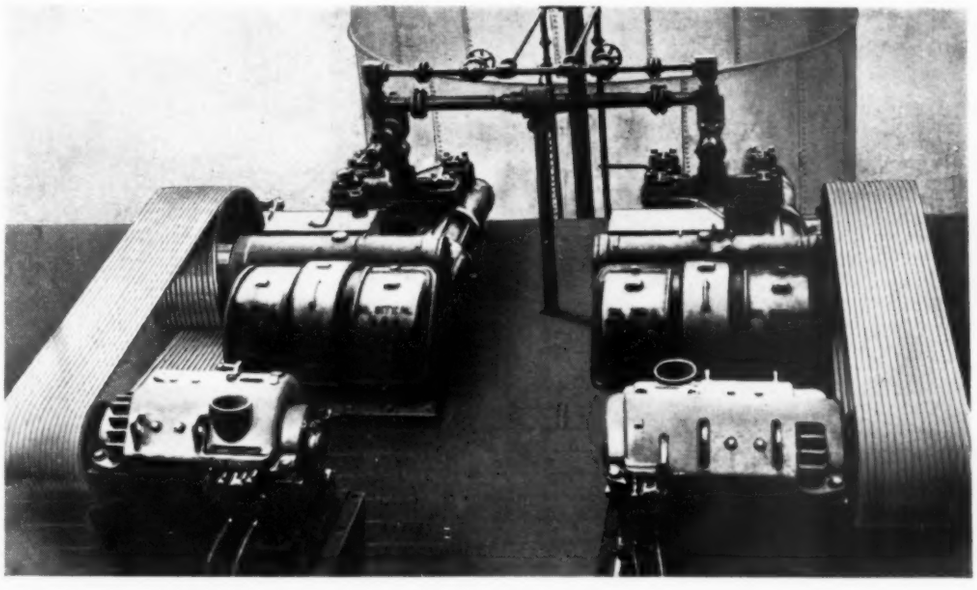
Double Reduction Unit.

In general, the construction of all V-belts is similar, consisting of a cord section designed to carry the load, surrounded by fabric. In designing V-belts, consideration must be given to the fact that there are three distinct areas in operation: the outside or tension area, the central, neutral zone, containing the cords to transmit the load, and the inside, or compression section. Various manufacturers have utilized different materials and methods to meet these operating conditions. In the selection of ropes, consideration should be given to the amount of "free rubber" used in proportion to the quantity of fabric and cord. The smaller the amount of rubber, the longer the life to be expected from the drive. Rubber is always used as a bonding medium between the layers of fabric, as well as between the strands of cord.

Aside from the standard V-belt drive, which consists of two sheaves, and the required number of belts, one manufacturer has developed some drives of particular interest. One of these drives, known as the "V-Flat" drive, consists of a small sheave, a flat pulley and the required number of belts. This combination was developed in attempting to so reduce the cost of V-belt drives as to make them available to everyone who is interested in modernizing their power transmission equipment. For this application only an especially true belt can be used, which will run satisfactorily on flat pulleys. The use of excessive rubber in the belt construction will cause them to have a tendency to twist or weave in operation, disqualifying them for this service. Another very novel application which has been worked out by a certain manufacturer is the "Double V" drive. The belt of this drive is similar to two standard V-belts attached back to back, thus either side of the belt will operate in the grooves of the sheave. No change is made in the sheave design. This belt is designed for such applications as long line shafts, where it is impossible or very costly to install belts around the sheaves. Idlers are used to hold the belts in contact with an arc on one side of the sheave. This application is clearly shown in one of the illustrations. This design may also be used where a number of sheaves are to be driven by one belt and contact must be made on both sides of this belt.

V-belt drives may be used as speed increasing as well as speed decreasing transmissions. The applications and calculations are the same for all moderate speeds. When the driven speed exceeds two thousand revolutions, centrifugal action must be taken into consideration. The smaller cross section belts must then be used, and it may be necessary for these belts to be specially constructed.

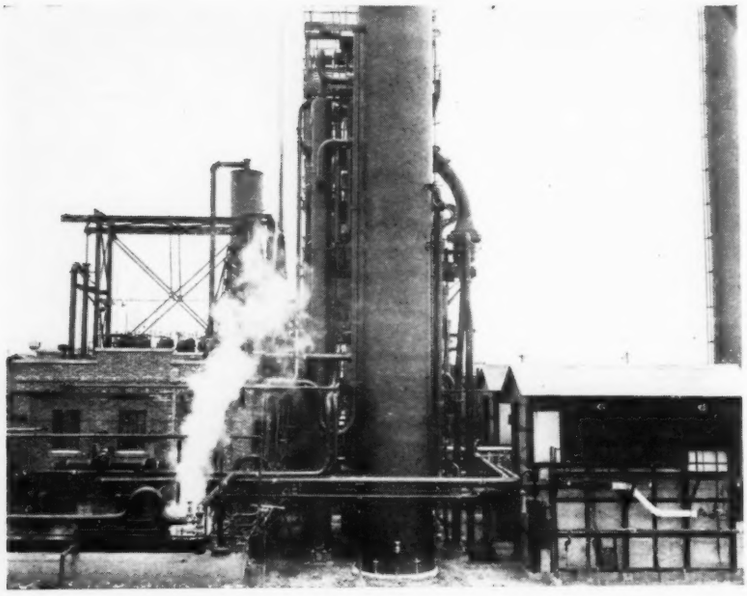
Although V-belt drives are now in use in every large industry, the number of applications is being continually increased.



Motor Driven Slush Pumps for Rotary Drilling.

Vacuum Plant Design

W. L. NELSON[1]



Modern atmospheric vacuum unit in an Oklahoma refinery.

THE refiner often approaches the installation and operation of vacuum equipment with doubt. During the last three years large scale vacuum equipment has been developed with gratifying success so that doubt concerning their usefulness should no longer exist. In reality, the design and operation of vacuum distillation equipment is little different from the design and operation of continuous atmospheric distillation units except that our physical data must be extended to embrace the lower range of pressure, and additional plant control equipment must be installed. Barometric condensers, ejector equipment, vacuum pumps for the products and vacuum controls have been perfected in commercial practice, and they may be installed without concern regarding their performance.

Of course, vacuum equipment is useful only for certain operations. Perhaps in over-enthusiasm, the industry has applied vacuum to certain operations that hardly justify the additional expense and added inconveniences of operation. Today vacuum plants are operating for the production of: (1) Lubricating oils from all bases of crude oil, (2) Lubricating oils from pressed distillate, (3) Lubricating oil from bright-stock solution, (4) Cracked gasoline from pressure distillate and (5) Gas oil for cracking purposes. With the exception of the first use, the economy of vacuum processing is questionable or at least is vitally dependent upon the particular conditions existing in the refinery. Doubtless the last four uses are advisable in many instances, but any of them can be successfully replaced by atmospheric steam distillation.

The merits of vacuum processing may be grouped under two main headings, namely: (1) the elimination of tar and dark-colored materials into a residue and, (2) the increase in the yield of products. The elimination of tar makes a large number of heretofore unsuitable crude oils available for the manufacture of lubricants. No longer are we dependent upon the production of light-colored crude oils for our supplies of lubricants. Many mixed-base and naphthene base oils contain as much or even more lubricants than paraffin base oils. This in itself, as an assurance of the market supply, is enough to justify the advent of vacuum processing. Previously, tar has been removed by costly filtering and acid treating operations. Vacuum products also require treatment, but the filtering operation has been largely eliminated and the acid required for treating has been dropped to about one-half (and sometimes much less) of the amount required for residual oils. Much lower temperatures are necessary in vaporizing under vacuum, and hence less material is thermally decomposed. Contrary to common belief, the products of the decomposition of lubricating oils are usually low-viscosity neutral oils and gas oil rather than gasoline. Thus an oil may be decomposed in shell-still practice without producing gaseous products or materially lowering the flash point. The loss of heavy lubricants in shell-still distillation using steam, often amounts to eight per cent, based on the crude oil, and increases the yield of neutrals and gas oil proportionally. The yields of lubricants are also increased by virtue of the less drastic chemical treatment that is required for vacuum stocks. In most treating operations a portion of the valuable lubricants is removed along with the undesirable coloring materials. In fact, some investigations have indicated that the most valuable lubricants are removed by treating. Certainly many technical white oils are among the poorest mineral oils. Finally, in shell-still heating, dark-colored tars, etc., are actually produced, and in vacuum operation (with [1] the lower temperatures required, [2] less time at high temperatures and [3] controlled heating conditions), these tarry polymerization products are not produced in large quantities.

Although the first pipe-still vacuum plants were built in Pennsylvania for the processing of paraffin base oil, such an application is not among the outstanding ones. Tarry crudes, such as Urania, Louisiana, crude and Coalinga, California, crude give total yields of lubricating oil stocks exceeding 50 per cent. Such yields are particularly interesting when we note that mixed and paraffin base oils do not usually yield more than 35 per cent and that 25 per cent is a more common figure.

Physical Data

In general the molecular weights of the normal paraffin hydrocarbons reduced by five per cent are a good average of the data on molecular weights. Apparently the obtaining of good data is a difficult laboratory operation because of the large range of data that are found in the technical literature. Below are tabulated the only high boiling-point data (of which I am aware), that can be depended upon for accuracy. The boiling points were corrected by Wilson's namographic chart of the vapor pressures of normal paraffin hydrocarbons.

MOLECULAR WEIGHTS

50% Boiling Point, °F	Normal Paraffins less 5%	Mixed Base	Asphalt Base	Paraffin Base (Texas)
500	197	197	.....	203
600	243	241	.....	250
700	301	297	296	311
800	374	368	378	382
900	457	462	450	470
1000	562	.....	625(?)	.....

Apparently the volume of petroleum vapor at low pres-

[1] Professor of Petroleum Refining, University of Tulsa.

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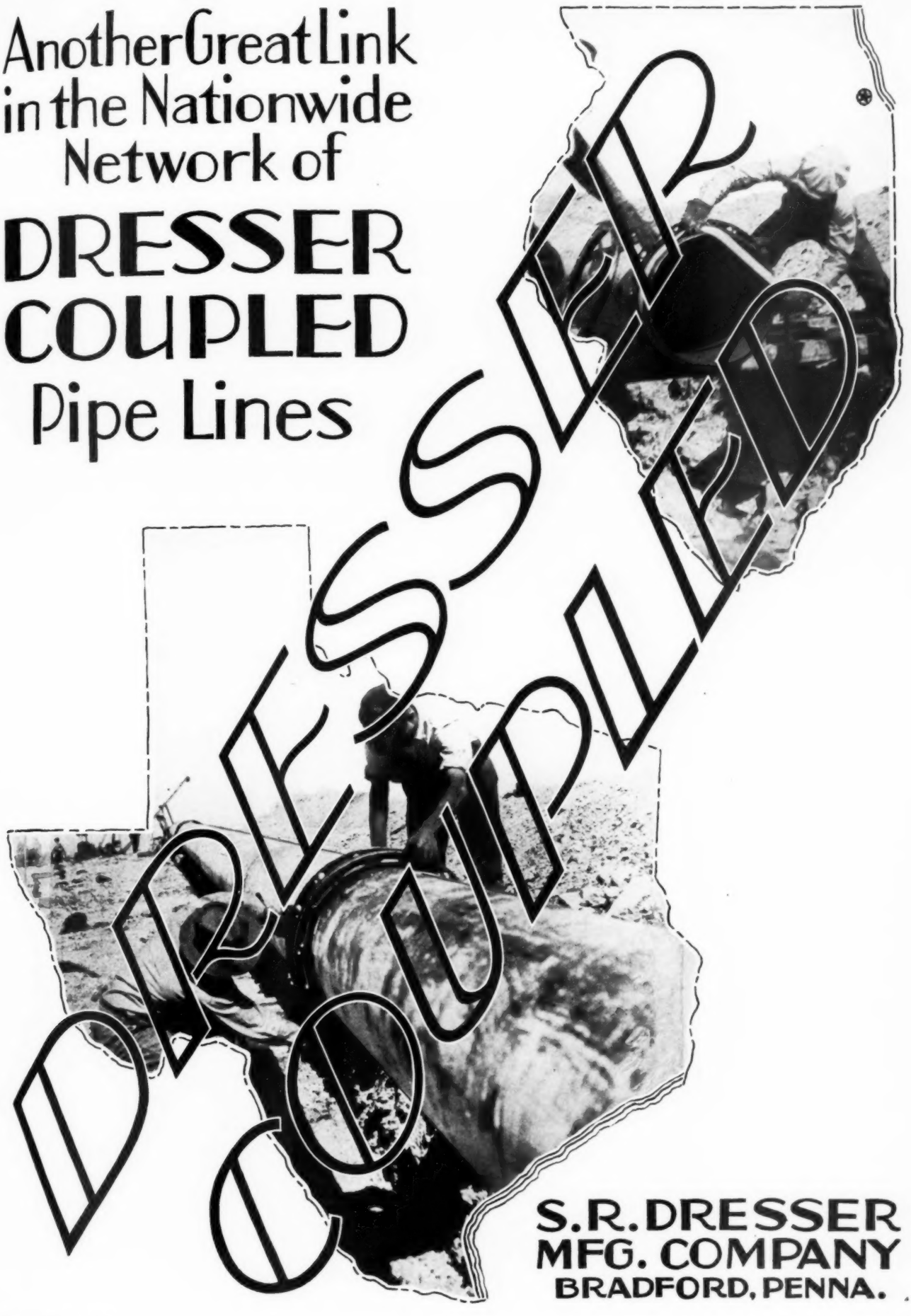

S. R. DRESSER MFG. COMPANY
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sures may be computed with assurance by the use of the gas laws for perfect gases. Van der Waal's equation of state gives nearly the same volumes as the gas laws and commercial experiments seem to indicate the same. Accordingly the volume of one gallon of 22 A. P. I. cylinder stock when vaporized at a pressure of 30 millimeters and at a temperature of 550 degrees F. would be:

$$\frac{7.67}{540} \times 359 \frac{760}{30} \times \frac{460+550}{492} = 266 \text{ cu. ft.}$$

The latent heat of vaporization is not a constant. As the pressure (or temperature), at which vaporization occurs, is increased the latent heat decreases until at the critical temperature it vanishes entirely. Conversely, at low pressures the latent heat increases, but the increase does not amount to more than approximately 20 B. t. u. per pound when the pressure is reduced to 30 millimeters. Cragoe's data in the Bureau of Standards Miscellaneous Paper No. 97, may be used. Due to the larger latent heat, the difference between the pipe-still outlet temperature and the vaporizer temperature is slightly larger than for a comparable atmospheric distillation process. Nevertheless, it should be borne in mind that the pipe-still outlet temperature is dependent on the quantity vaporized in the tower and the vaporization that occurs in the pipe-still or transfer line as well as the latent heat, so that the difference in the pipe-still outlet temperature and the vaporizer temperature will depend upon all of these conditions.

Flash evaporation data at reduced pressures is at the same time the most important and the most troublesome data necessary for design of vacuum equipment. Customary methods of approximating flash temperatures[2] are hardly adequate for vacuum design. In these methods a straight line vaporization curve is obtained and while throughout the middle of the line, the data are accurate enough, at the ends of the distillation a curvature exists in the vaporization curve. In atmospheric design, errors in the flash temperature can be compensated for by the use of additional steam, but in vacuum distillation the necessary quantity of steam in case of an error cannot always be used because the size of the fractionating equipment will often be excessive or exceed economical structural limits. Approximations can be made by means of the aforementioned methods, but usually it is necessary to obtain the flash vaporization curve directly by vacuum flash vaporization determinations in the laboratory. Because of this difficulty, many designers have merely specified the maximum pipe-still outlet temperature of 780 to 810 degrees F., using an arbitrary quantity of steam, and have allowed the yields to be what they will at these conditions.

Vacuum Processing

Although shell-still vacuum units have been in operation for many years, vacuum processing was not a true success until the combined merits of controlled (pipe-still) heating and efficient fractionations could be applied. With few exceptions the plans that have been installed are of the most simple, direct processing type. Reduced or topped crude oil is heated in a single pass radiant type pipe-still and flashed into a tower operating at a reduced pressure. The vapors ascend the tower and are condensed by reflux and drawn from plates (or trays) in the tower or are allowed to pass overhead to be subsequently condensed and separated by partial condensation. Usually the gas oil is condensed in partial condensers (and sometimes wax distillate), but the cylinder stock and other heavier products are drawn from trays in the vacuum tower. Steam is invariably used to further reduce the partial pressure of the oil vapors. Without steam (the hypothetical dry method) the vaporizer section of the tower would have to operate at pressures lower than five millimeters for the production of distilled cylinder stock. Inasmuch as barometric condenser and jet equipment cannot economically produce a pressure lower than about 10 millimeters, the use of steam is always necessary. Gas oil or wax distillate is pumped into the top of the tower to control the temperature, but the use of reflux condensers in the top of the tower (heating the incoming charge) is advantageous because they decrease the size of the vapor line and each auxiliary equipment. The products are either removed directly by oil sealed (or immersed) centrifugal pumps or indirectly by plunger pumps taking suction from evacuated temporary receiver tanks.

Efficient fractionation is vitally essential because the subsequent dewaxing and treating operations cannot be successfully carried out unless the products have been well separated. Tar in the cylinder stock causes larger treating losses and the stock cannot be centrifuged if too much crystalline wax is present. Likewise amorphous wax causes the wax distillate to be unpressable. For this reason it is advisable to supply about 20 per cent more reflux than is required by a heat balance over the tower[3] if such does not cause the outlet temperature of the pipe-still to exceed 780-810 degrees F. Sometimes it is necessary to produce a two to four per cent slop-wax cut, which contains crystalline wax that would ruin the cylinder stock and also amorphous wax that would ruin the wax distillate. However, such a cut can be avoided if (1) excess reflux can be supplied, (2) low velocity, efficient fractionating equipment is used and (3) vacuum steam strippers are installed for the side-stream products. Pressable wax distillate up to a viscosity of 120 seconds at 100 degrees F. has been produced, but most plants prefer to produce an 80-90 viscosity distillate. Cylinder stocks ranging between 90 and 160 seconds viscosity at 210 degrees F. have been successfully centrifuged.

Since treating and dewaxing are by far the most expensive operations in the finishing of oils, plant design in the future will probably be more and more subservient to these operations. Residual stocks are usually dewaxed before chemical treatment, but the reverse is true of vacuum stocks. Vacuum processes of the future will probably produce a single lubricating oil stock which will be dewaxed and perhaps even treated before it is separated into commercial oils by another vacuum distillation. In such a process the initial vacuum flashing operation would be quite efficient because a lower pressure (perhaps 13 millimeters) could be maintained at the flash point and only one clean separation, that is between "lub" oil and tar, would need to be made. At the same time condensation under vacuum is expensive and the double condensing operation would increase operating costs. Nevertheless, the overall operation of two distillations, dewaxing and treating, would probably be less expensive than the present processing methods.

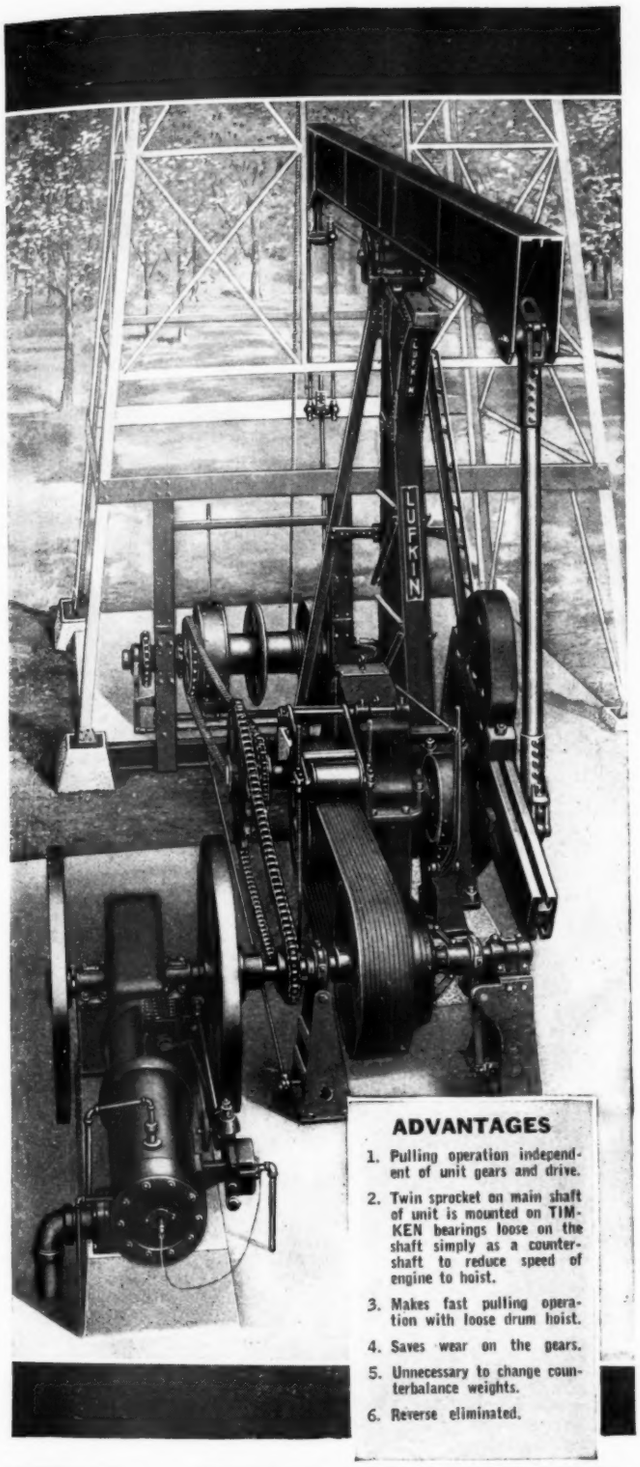
In a subsequent article some details of vacuum equipment and a typical design calculation will be presented.

THIS MONTH'S COVER

For the cover this month we have reproduced a closeup view of the 14,000-barrel per day two-stage distillate unit taken before insulation was applied at the Port Arthur, Texas, plant of the Gulf Refining Company. Shown in the foreground is a vacuum flash jug which greatly increases the yield of overhead cylinder stock by reducing the bottoms from the vacuum flash tower. This unit was constructed by Foster Wheeler Corporation and we make thankful acknowledgment to them for use of this photograph.

[2] Nelson and Souders. The Petroleum Engineer, page 131, October, 1931.

[3] Nelson and Souders. The Petroleum Engineer, page 131, October, 1931.



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Deep Drilling Casing Practices

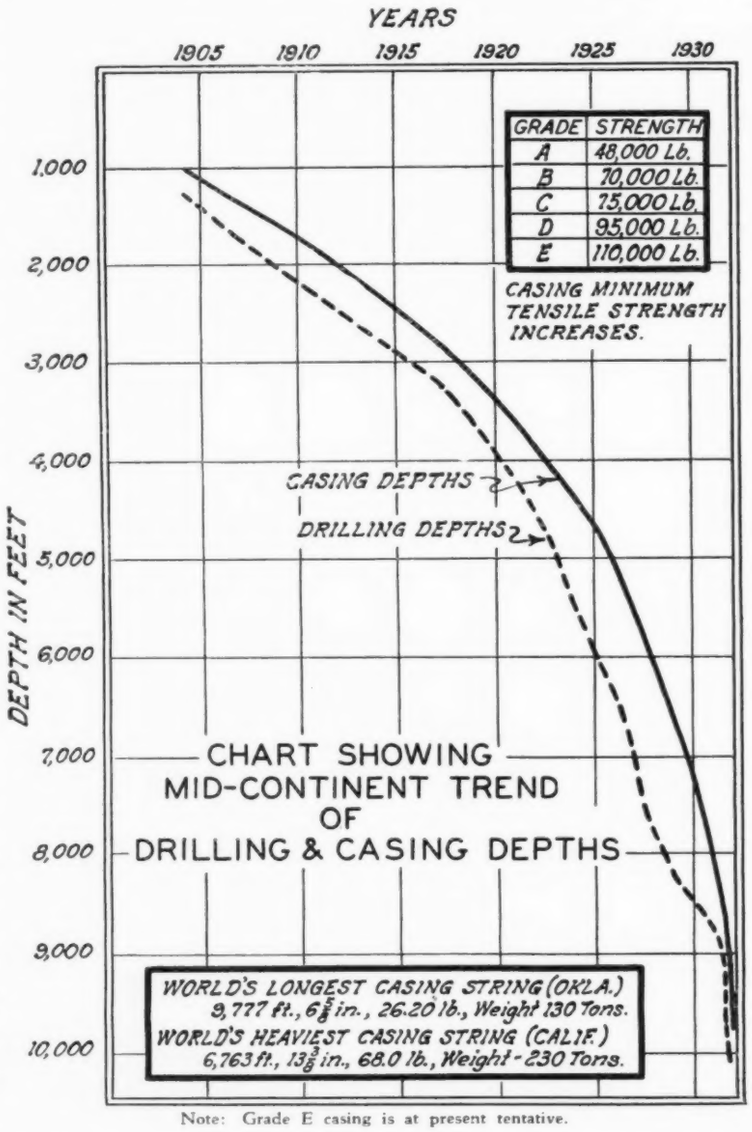
By WARREN L. BAKER

THE subject of deep drilling has become of increased importance in recent years, when the oil industry's trend toward greater depth holes has been materially magnified. Less than four score years ago the world's first oil well, Drake's "Folly", was completed at the depth of 69½ feet; at which time no one visualized 10,000 foot deep holes, but today holes of such great depth have actually been drilled and even deeper penetration into the earth is possible. There are many important lessons to be found in the drilling history of deep wells that will be the basis for future deep drilling methods and practices.

Pipe Clearance and Diameter of Holes

The greatest lessons from the three wells that have reached depths beyond 10,000 feet probably are the advantages to be gained by having an ample clearance between pipe strings for circulation purposes and a good-sized diameter hole as far as is possible.

Considerable attention is being devoted at this time to means of obtaining greater clearance between strings of pipe. Some operators and contractors use underreamers, while others favor the employment of special pipe joints. Where the clearance must be of a maximum amount, the use of the male-female inserted joint is increasing, particularly in California fields. This type of joint is flush both inside and outside with the drill pipe, therefore not protruding into the annular clearance space between strings or into the open hole if below previous set casing, leaving a greater clearance, which makes rotary mud circulation much more free and consequently easier. A number of manufacturers are making several different styles of these flush type joints.



Note: Grade E casing is at present tentative.

While flush joint drill pipe has been used extensively in many areas, thus far, in only one instance has flush joint casing been used, but its success with drill pipe operations and the fact that flush joint equipped casing would have the same advantages, doubtlessly will cause some interesting study along these lines.

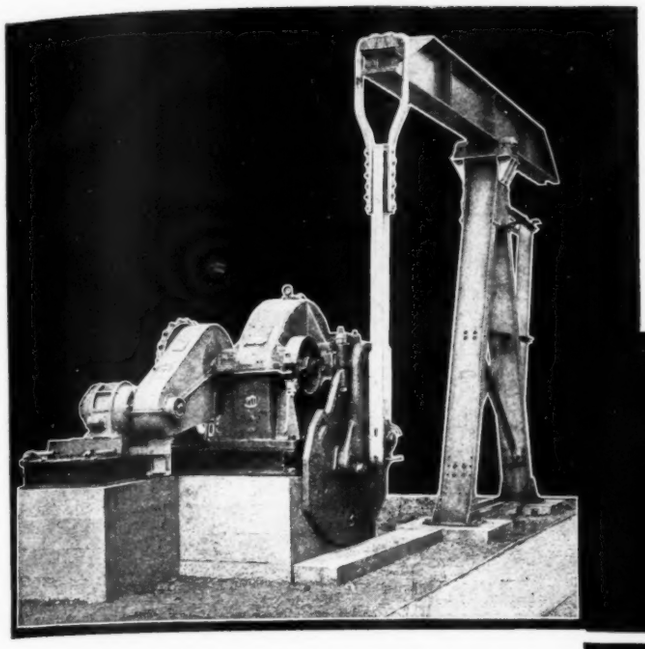
None of the three 10,000-foot holes were commenced at the surface with the prelaid plan of reaching 10,000 feet, and only one of these was started with the idea of being a deep test in any way; and this test penetrated to a new world's deep record despite various unusual handicaps that were found. The lack of preliminary plans enlarges the accomplishments of these wells, future 10,000-foot holes will be much easier and safer when plans are laid in advance of commencing drilling operations.

All three tests had difficulty in making hole after reaching 10,000 feet, because at this depth it was practically necessary to set another string of casing, which would have made the hole very small for further drilling purposes. This factor causes the usage of small drill pipe and trouble in circulating, thereby placing definite limitations on the possible ultimate depth that might otherwise have been reached. This trouble can in a measure be overcome by setting a larger size surface pipe, drilling a greater diameter hole and using longer and larger diameter subsurface casing strings, but this statement must be qualified by saying that it would not be economical to use more pipe strings than would be necessary to reach the desired depth.

The future practice in drilling tests below present penetrated depths will probably be a combination of several methods including the use of a larger size surface hole, extension of the length of each sub-surface pipe string, and employment of underreamers and flush joint drill pipe and casing.

Casing Factors

Drilling to lower zones makes the question of the stress on casing of great importance. As drilling continues



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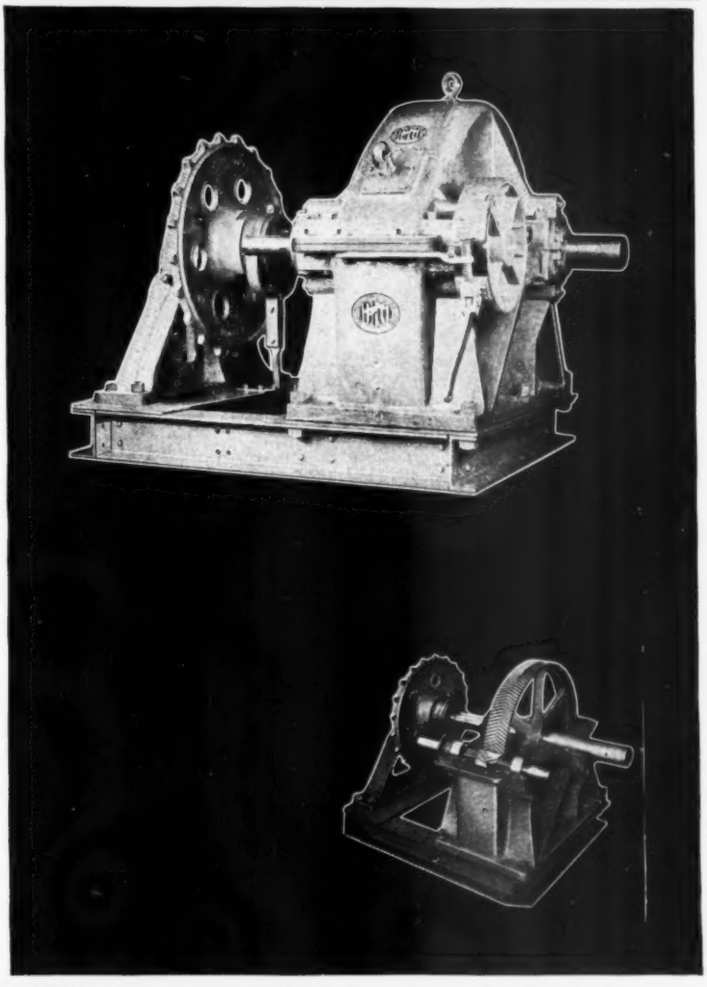

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The IDECO Counterbalanced Crank with its wide range of adjustments, effectively balances the weight of rods and fluid . . . . Its flywheel effect smooths out power peaks and reduces power requirements.

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deeper, casing programs require heavier casing of stronger material, so, today, manufacturers offer 6⅝-inch casing with tensile strengths of 100,000 pounds minimum, and even then safety factors under different conditions arise at greater depths.

During the last 25 years, a tremendous change has taken place in the tensile and collapsing stresses placed on casing, the pressure at the bottom of a 900-foot hole, equivalent to the pressure caused by an equal column of water, is only 450 pounds per square inch, whereas the equivalent water pressure corresponding to a 9,500-foot well would be 4,762 pounds per square inch.[1]

There are a number of conditions to be met in running long strings of casing: First, the stress tending to shear the threads from the pipe; second, stress tending to cause the failure of the metal at the root of the first perfect thread; third, lateral contraction of the pipe and coupling and the elongation in tension; and fourth, contraction of pipe and expansion of coupling due to angle of thread.

There is an increasing practice of using long couplings and longer threads on the pipe, which type of joint is stronger to a certain extent than the shorter couplings, but the tensile strength of a threaded connection never can be greater than the ultimate strength of the net area of metal below the root of the first perfect thread. These couplings in some cases are larger, while others have the same outside diameter as A. P. I. couplings and have standard thread form and taper.

When a long string of heavy casing is to be run, provision is usually made to float the casing in by use of float valves and float plugs, which are placed near the bottom of the string. The purpose of these is to reduce the stress and strain on surface equipment and in the upper portion of the pipe string. The number and capacity of plugs used depends upon the length casing string and its weight. With mud weighing 10 pounds per gallon and 4¾-inch, 16-pound per foot, casing, the floating-in method of running pipe will reduce the dead weight load to 56 per cent.[2]

It is essential when floating casing into the hole that the fluid level within the pipe never be permitted to become too low, as under 1,000 feet, because the hydrostatic pressure will collapse the best of casing. For this reason the casing string is filled with mud after running approximately 20 joints.

In many areas, particularly in the Mid-Continent, the final or flow string of casing is run with rotary equipment by using the cat-head. This system, while it has been successful, requires precautions because it is conducive to fast speed and has a tendency toward side pull on the pipe. An improvement on this method and one used on all deep strings is to first start the pipe making-up with hand tongs, after which the rope is used by wrapping one end around the pipe several times and the other end is placed around the cat-head. Final degree of tightness to the pipe is secured with pipe tongs.

During screwing-up of pipe, careful inspection should be made of the manner the casing is making-up, so no joints will be galled or damaged threads will be run and the pipe string greatly weakened. This inspection may include watching the engine and jerk line actions, from which the force necessary to tighten each joint may be seen. The amount of threads exposed after making-up is also of importance and should be practically uniform on all joints if the pipe is properly made up. If too much heat is apparent (determined by placing the bare hand on each collar while screwing-up) the pipe is being made-up too rapidly. The chances of pipe string failures may be greatly reduced by close inspection and by proper cleaning and leading of the joints before stabbing.

The consistency and weight of mud fluid used in floating-in casing has a vital bearing on the speed and successful landing of the pipe. When the mud is too thick, circulation is likely to become sluggish and perhaps stop entirely. If pumping is continued after such a condition has arisen, the mud in the hole will become highly compressed and ultimately will form a bridge. Thick muds are particularly troublesome where small clearances are to be found between casing strings as the greater friction of flow in such cases would practically make it impossible to gain free circulation.

Cementing Problems

Increasing depths of casing land points have been instrumental in requiring a quickening of cementing time, as naturally a greater period of time is required to place cement behind a longer casing string, and the time consumed must not exceed the time in which the cement will set.

Where an exceptionally long string of casing is to be cemented, it is desirable not to hasten the setting of cement because of the time required to pump this cement into the proper place, and it may be difficult to obtain the desired results if the pipe sets tightly in the hole. It is common when a long string is to be cemented to start the cement into the well with an increased water ratio and reduce the water content as the end of the cement is reached. This makes it easy to pump to its place on the outside of the casing, because the first run of cement is quite thin and when the column of cement is in the place, the heavier mixture is at the casing shoe where strength is especially desired.[3]

Cementing companies have made great progress in quickening cement pouring time, and have been able to successfully cement at great depths. The speeding up of cement operations has been obtained by arrangement of mechanical equipment and the use of additional cement trucks of the large, heavy pressure type, together with a better knowledge and understanding of cement engineering phases.[4]

Another factor entering into the cement field as holes are bored deeper and deeper, is the increasing temperature at the bottom of the hole. The Mid-Kansas Oil & Gas Company and Ramsey Petroleum Corporation's Preston-Culp No. 6 was estimated to have a bottom hole temperature of 200 degrees F. at 10,000 feet. The increased temperature has the effect of accelerating the setting time of cement, and to overcome this problem, operators are using many tons of ice to cool the circulation mud prior to cementing.[5]

The mechanical details of cementing long strings are practically the same as for short strings, except for the need of increased speed and consequently greater pressure. These details include actual placing of the cement into the mixing chamber and pumping of the mixture from there to the well and then to the desired position in the hole.

Equipment for this purpose includes self-contained and self-powered motive units. Two or more trucks are used at each well, depending upon the conditions. These truck pump units are so connected that the pumps may be compounded, when pressures up to many thousand pounds are possible.

Prior to the cement operations, engineers must determine where the pipe is to be set, amount of cement to be used, and must also see that the hole is properly prepared and the right connections are made.

It has become a field practice on deep tests to recondition the rotary mud before cementing. This is done by screening it, which removes large particles that might clog up the hole after the new pipe string is in place. Frequently, commercial clays are added to the mud so as to increase its velocity and viscosity.

[1] Development of Casing for Deep Wells, by F. W. Bremmer, A. P. I. Meeting, Chicago, September, 1930.
[2] Analysis of Casing Stresses and California Casing Practices, by C. J. Coberly, Kobe, Inc.
[3] Handbook of Oil Well Cementing, Halliburton Oil Well Cementing Co.
[4] 5500 Feet of Casing Cemented in 34 Minutes, The Petroleum Engineer, January, 1932.
[5] Unusual Drilling Conditions in New Colorado Pool, The Petroleum Engineer, November, 1931.

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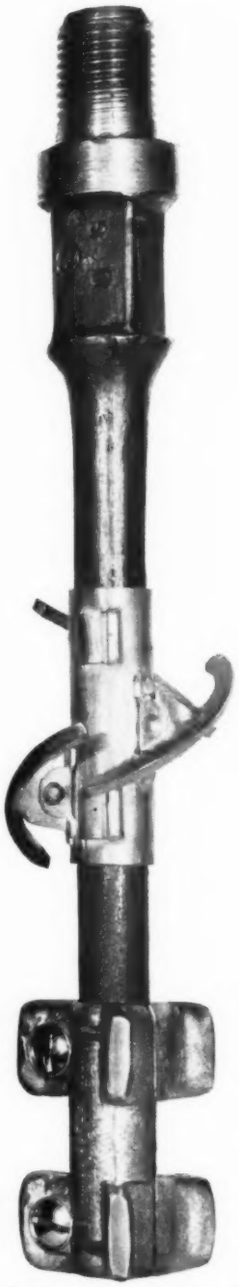

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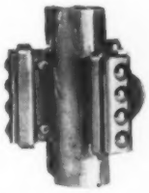

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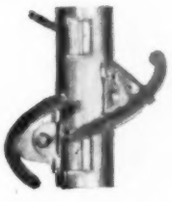

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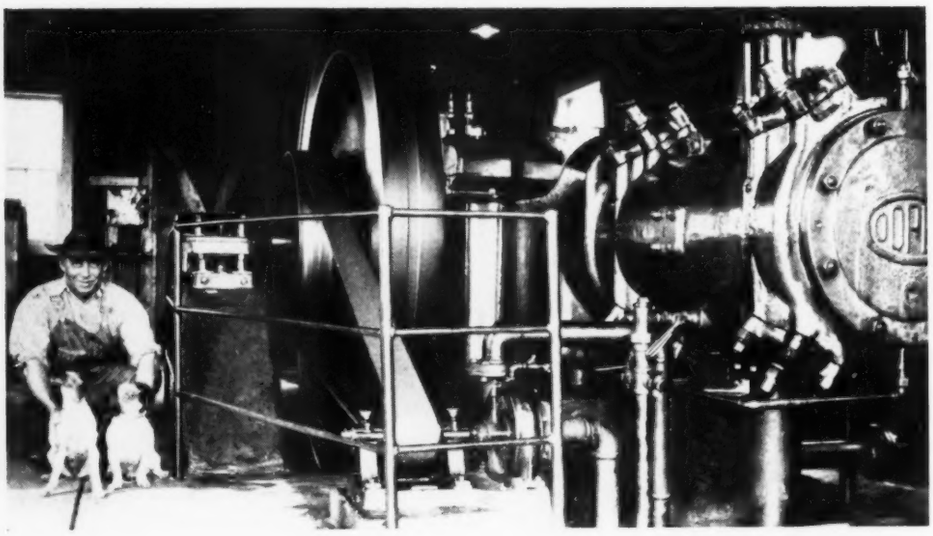


E. W. Keller, operator of the Altamont station, and the compressor which made an exceptional run.

The Record-Breaking Performance *of a Gas Compressor Unit*

By C. J. WATSON, *Cities Service Gas Company*

PRESENT-DAY loads and service of gas transportation systems are essentially dependent on the performance of their prime movers.

Foremost consideration must be given the compressor units. Through them a constant volume of gas is available at distant markets, and the variable demands of industrial and domestic loads met.

Care and deliberation must govern the selection of types and sizes of compressor units, not only to meet present requirements but future expansion and possible standardization. Much is expected of them. Mechanical simplicity and reliability are essential; economic operation a necessity. Performance, the total of all virtues embodied in the unit, can only be determined by constant operation.

Noteworthy from the above standpoint is the recent performance of a gas-driven compressor unit on one of the gathering systems of the Cities Service Gas Company.

This compressor unit, a type in common use over the wide-spread gathering systems of the gas industry, is the nucleus of the "One Man" Altamont booster station located in Labette county, Kan. It is composed of 1—85 H.P. horizontal, single stage, 4-cycle, single-acting gas engine; direct-connected to one 12½"x20" compressor cylinder. In addition the engine belt drives a 3" centrifugal water pump for circulating cooling water.

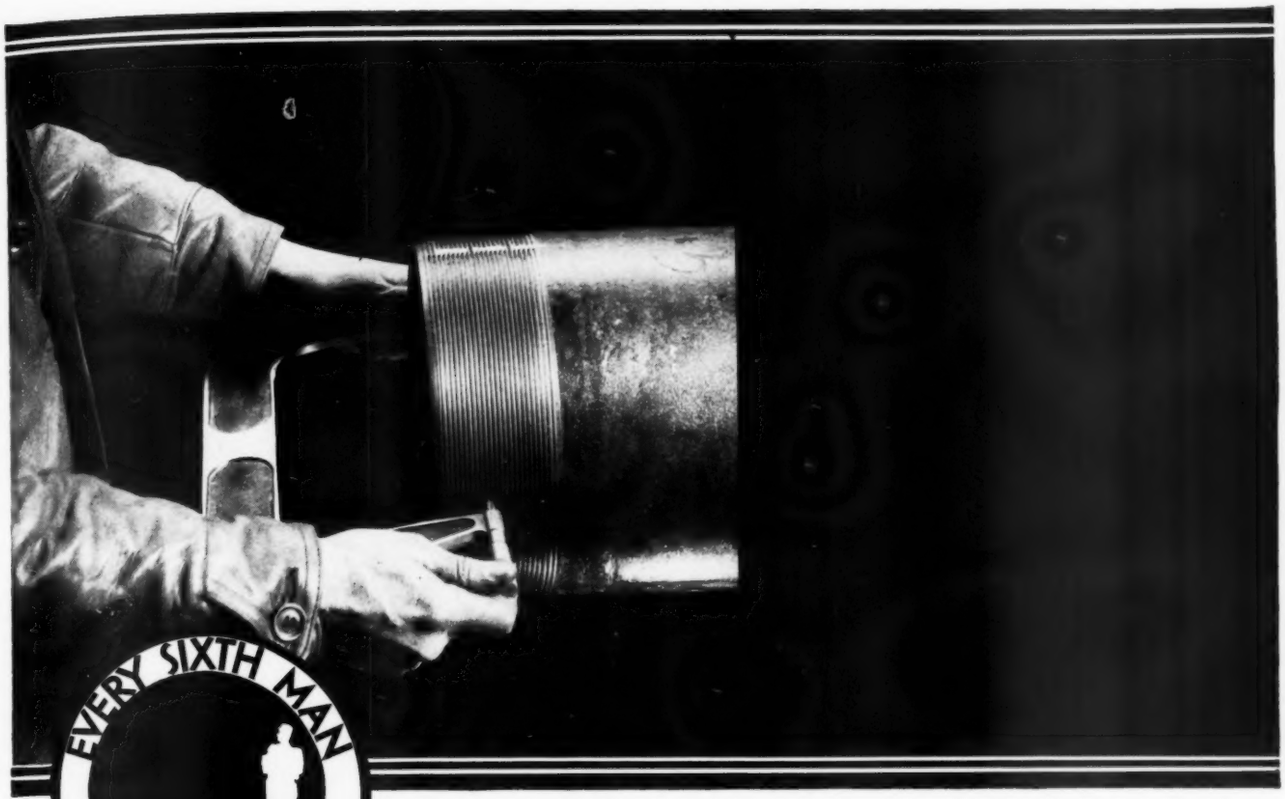
When recently shut down by the pressure dispatcher this compressor unit was found to have completed an unbroken run of 6 months, 12 days, 7 hours and 15 minutes without a single interruption, accident or shutdown.

Thoroughly examined and checked after this run the entire machine was found to be mechanically true and smooth. No loose or worn parts were found and the ignition system was in excellent condition. Cities Service Oils were used exclusively for lubrication.

Although the station operator could not be constantly on duty during the time he was at the station he made particular note of its condition when there. By carefully watching for sources of possible trouble and correcting them before even minor trouble developed the unit was kept in operation constantly. Particular attention was given to the lubrication system to insure a sufficient quantity of oil reaching the bearings and other points of lubrication. This, in connection with a clean station preventing accumulation of dust about the unit, is one of the reasons for its good run.

Considering the fact that during this run the unit was constantly under fluctuating intake and discharge pressures with compression ratios ranging from 3.5 to 15.2; that the slightest loosening of a mechanical part or decrease in flow of oil or water would have caused the automatic cutouts to stop it; that in all phases of operating economy it averaged lower than that claimed by the manufacturers, and that being under only one man operation it could be watched only part of the time, surely this unit is entitled the rating of excellent in performance and any other credit due it on the basis of its record run.

The Altamont compressor station of the Cities Service Gas Co. in Labette County, Kansas.



CONSTANT care and unceasing vigilance in manufacture explain why J & L Seamless Pipe holds its enviable place in the estimation of pipe users. Five men out of every six in the Seamless Tube department make the pipe—the sixth man inspects it. He's on our payroll, but he works for you.

One of the many inspections is the checking of thread taper. With this taper right, both on pipe and in couplings, strings of pipe make up easier and quicker. The coupling covers all the threads. It never goes on too easily, yet never needs forcing. Every pipe thread has full bearing with the corresponding thread on the coupling. Tight joints are assured, and every portion of the thread does its full share in transmitting pull, and resisting mechanical strains. Couplings can be backed off easily and used again, for the threads are not rolled. They stay sharp and accurate.

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Critical J & L inspectors make enthusiastic users. They also make the J & L mark on Seamless the stamp of uniform quality, dependable service, and long-time satisfaction.

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AMERICAN IRON AND STEEL WORKS

JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

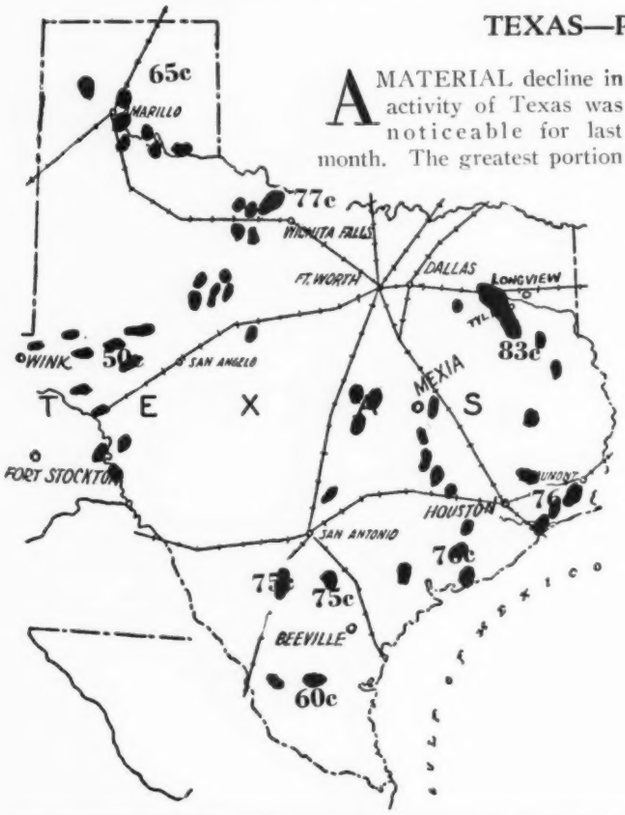
Manufacturers of Seamless and Welded Casing, Tubing, Drill Pipe and Line Pipe, and Welded Steam, Gas and Water Pipe in both Black and Galvanized

J&L STEEL

Also makers of Bars, Shapes and Plates, Reinforcing Bars, Cold Finished Steel, Junior Beams, Steel Piling, Fabricated Structural Work, Steel Barges, Wire Products and Tin Mill Products

Latest Activities *in the* Oil Fields*

TEXAS—Production, 1931—330,720,000 Barrels



A MATERIAL decline in activity of Texas was noticeable for last month. The greatest portion of the drop was in the East Texas fields, but must be contributed to high waters and impassable conditions of roads which prohibited transporting of equipment to new well sites. Because of the conditions now affecting activities the decline cannot be considered permanent.

The state had 356 locations, 408 completions, 333 rigs and 624 drilling wells for the month of January.

Following is a tabulated report of the active areas:

POOLS	East Texas	Panhandle	Van	Refugio
Number of Permits	225	2	6	1
January Completions	272	9	5	1
Number of Rigs	79	10	1	0
Number Drilling Wells	536	25	8	3
Gravity of Oil	40	40	36	26
Depth of Production	3600	2900	2600	6500
Type of Tools Used	Rotary	Rotary	Rotary	Rotary
Number of Casing Strings	2	2	2	2

CALIFORNIA

Production, 1931—188,575,000 Barrels

California had a total of 14 completions during the month of December, during which time 15 new locations were staked, and 140 tests were drilling, while 15 locations were listed as rigs.

California activity continues to be very routine, with all promising areas heavily regulated as to both drilling and production.

A survey of activities in principal fields follows:

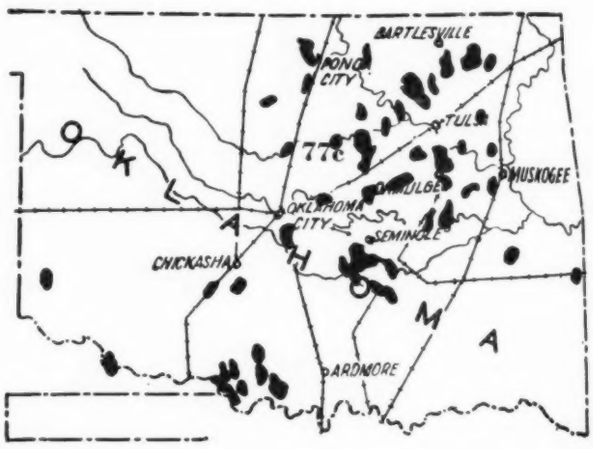
POOLS	Playa Del Rey	Long Beach	Kettleman Hills	Ventura
Number of Permits	1	1	0	1
January Completions	0	3	1	1
Number of Rigs	1	1	0	1
Number Drilling Wells	3	15	10	3
Gravity of Oil	23	26	60	36
Depth of Production	6000	7000	8300	7800
Type of Tools Used	Rotary	Rotary	Rotary	Rotary

*All statistics as of February 1st.

● Denotes oil and gas fields.

OKLAHOMA

Production, 1931—177,750,000 Barrels



Operations in the field continue to remain quite low in Oklahoma, with the principal activity at Oklahoma City. A slight increased interest is being shown in several wildcats in the Seminole district.

Following is a summary of Oklahoma's activity:

	Entire State	Oklahoma City
Number of Permits	48	8
January Completions	52	8
Number of Rigs	48	16
Number Drilling Wells	126	31
Gravity of Oil	36 (average)	39
Type of Tools Used	Rot.-Cab.	Rotary
Number of Casing Strings	Varies	3

Figures on maps indicate average prices of crude oil per bbl.

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"CALIFORNIA SPECIAL"
REG. U. S. PAT. OFF.
Cable-Tool Drilling Lines
"HERCULES" (Red Strand)
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Drilling and Casing Lines
SAND LINES - - TUBING LINES
SUCKER ROD LINES

Write for Our
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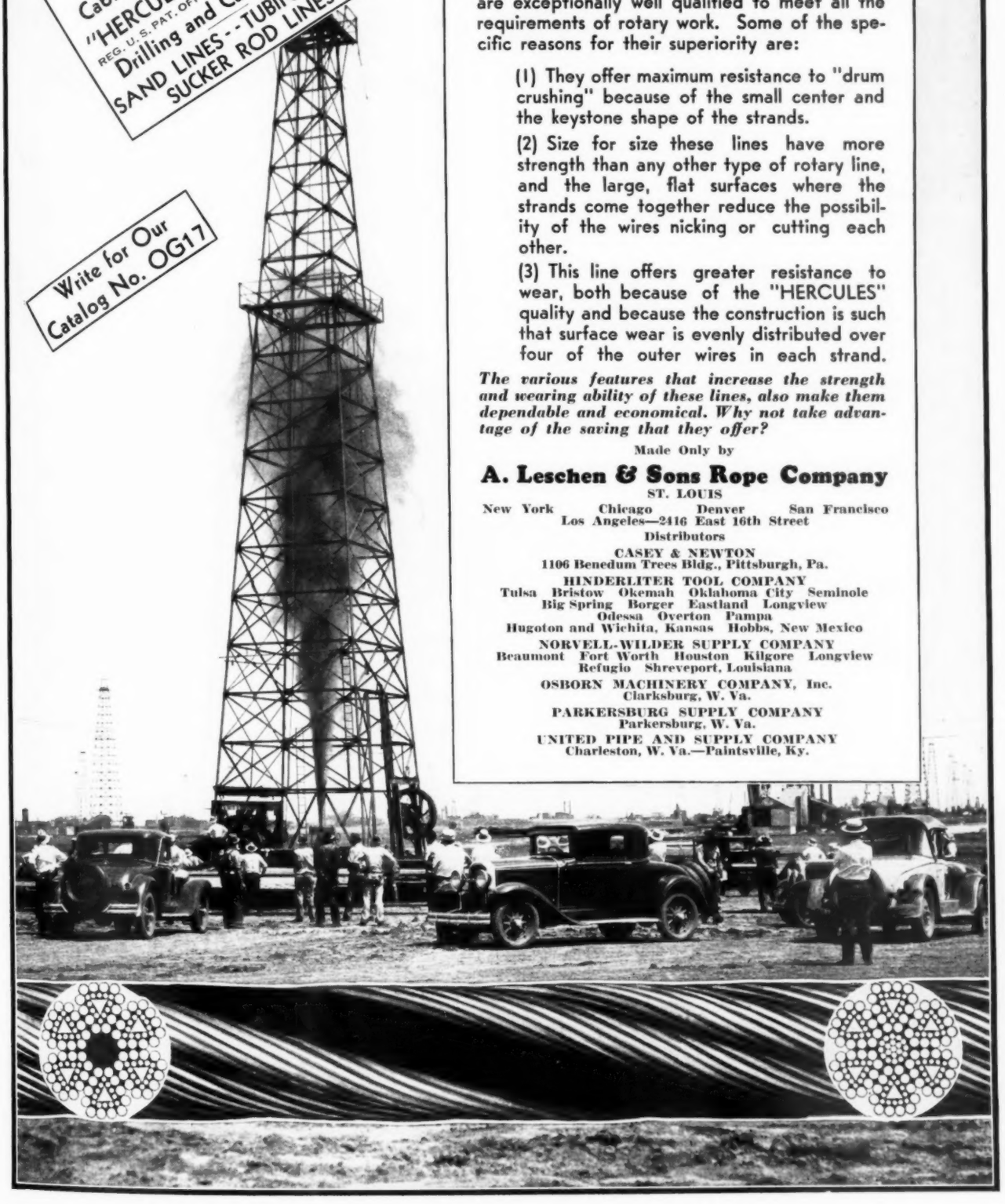

Patent Flattened Strand

"HERCULES" RED-STRAND

REG. U. S. PAT. OFF.

Rotary Drilling Lines

are exceptionally well qualified to meet all the requirements of rotary work. Some of the specific reasons for their superiority are:

(1) They offer maximum resistance to "drum crushing" because of the small center and the keystone shape of the strands.

(2) Size for size these lines have more strength than any other type of rotary line, and the large, flat surfaces where the strands come together reduce the possibility of the wires nicking or cutting each other.

(3) This line offers greater resistance to wear, both because of the "HERCULES" quality and because the construction is such that surface wear is evenly distributed over four of the outer wires in each strand.

The various features that increase the strength and wearing ability of these lines, also make them dependable and economical. Why not take advantage of the saving that they offer?

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UNITED PIPE AND SUPPLY COMPANY
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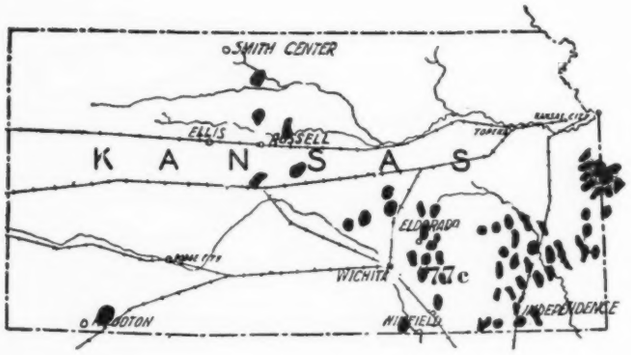
KANSAS—Production, 1931—37,950,000 Barrels



There were 43 new drilling permits and 33 completions made in Kansas during January, while 39 rigs and 69 drilling tests were carried on the activity report. Both rotary and cable tools are used in the state, with the latter the most common.

Interest is at present centered in the new area along Ellsworth Arch, covering Ellsworth, Barton, Stafford and Lyons counties.

	POOLS		
	Sedgwick County	Ellsworth Arch	McPherson County
Number of Permits	5	8	14
January Completions	8	1	8
Number of Rigs	1	5	15
Number of Drilling Wells	10	8	22
Gravity of Oil	39	37	38
Depth of Production	2900-3500	3200	2900-3400
Type of Tools Used	Rot.-Cab.	Cable	Rot.-Cable
Number of Casing Strings	2	4	2

ARKANSAS

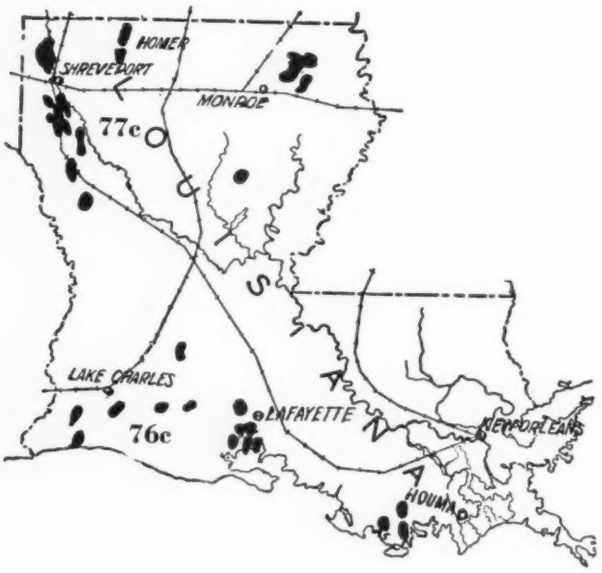
Production, 1931—15,425,000 Barrels

There were 8 rigs and 27 drilling tests at the end of last month in Arkansas, during which time only one new location was made and but one completion.

Rotary type of tools are used by contractors for drilling purposes in the state, where formations frequently carry large gas pressures and are usually soft and cavey.

LOUISIANA

Production, 1931—22,325,000 Barrels



Thirty-one new drilling permits, 27 completions, 15 rigs and 70 drilling wells comprised the oil field activity of Louisiana during January. Rotary tools are operated in both the Gulf Coast and North Louisiana areas.

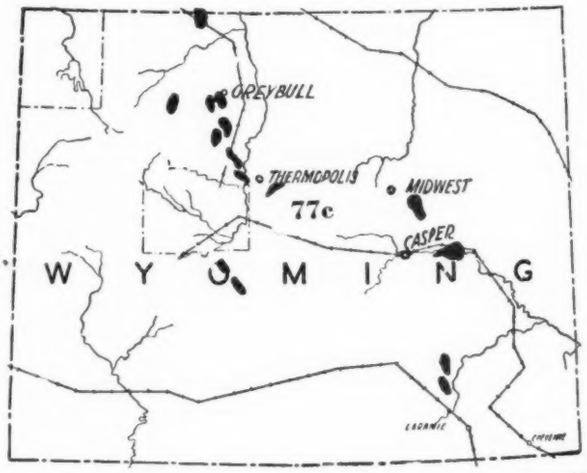
In Mississippi, east adjoining neighbor state of Louisiana, there were 9 completions, 9 rigs and 20 active drilling tests. The activity of this state is centered around the Jackson gas region.

● Denotes oil and gas fields.

WYOMING

Production, 1931—14,725,000 Barrels

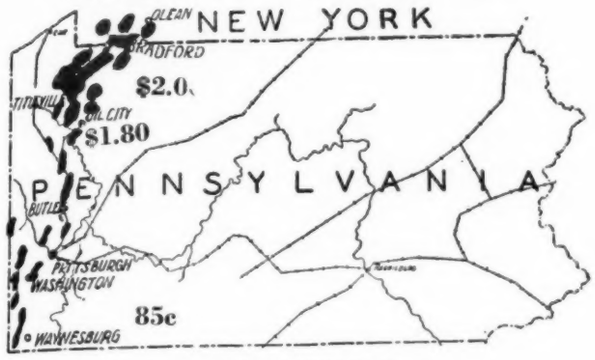
There were 3 completions, 10 rigs and 68 drilling tests in Wyoming last month. Practically all the tests in the state are drilled with cable tools.



Figures on maps indicate average prices of crude oil per bbl.

NEW YORK

Production, 1931—3,400,000 Barrels



PENNSYLVANIA

Production, 1931—11,225,000 Barrels

A total of 46 tests were completed in Pennsylvania last month. The state had 18 rigs and 75 drilling tests. New York had 11 completions, 2 rigs and 15 drilling tests. Drilling in both states is conducted with cable tools.

ILLINOIS

Production, 1931—4,850,000 Barrels

Illinois had but one completion in its oil fields during the month of January, and had no rigs and locations, while 20 tests were drilling within its boundaries.

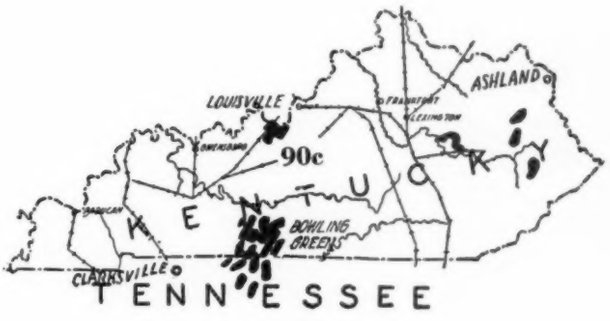
Standard tools are used by operators to drill the oil tests in the state, where producing horizons are shallow and usually easily reached.

● Denotes oil and gas fields.

KENTUCKY

Production, 1931—6,490,000 Barrels

A total of 38 tests were completed in Kentucky last month. The state had 7 rigs and 65 drilling tests. Tennessee had but 13 drilling tests on its activity report. Cable tools are used by operators in both states.



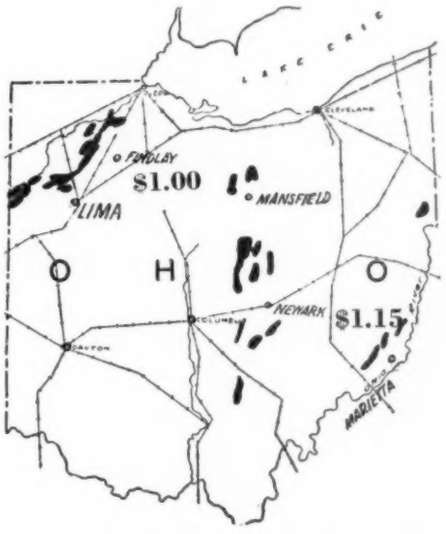
TENNESSEE

Production, 1931—8,000 Barrels

OHIO

Production, 1931—5,315,000 Barrels

There were 70 completions made in Ohio during the month of January, and 120 tests were drilling and 35 operations were listed as rigs and new locations. Cable tools are utilized for all drilling purposes in the state, where producing horizon are comparatively shallow and easily reached.



WEST VIRGINIA

Production, 1931—4,480,000 Barrels

A total of 51 completions were made in West Virginia, 25 rigs and 35 drilling tests comprised the remainder of the state's oil field operations. Standard tools are used to conduct drilling operations.

Figures on maps indicate average prices of crude oil per bbl.

NEW MEXICO

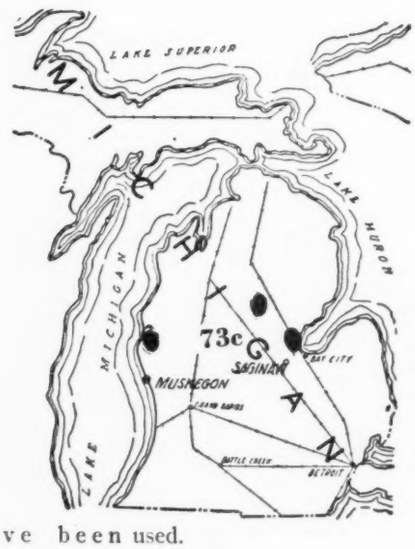
Production, 1931—15,250,000 Barrels

The state of New Mexico had 3 completions during the month of January, at the close of which time there were 4 rigs and 50 drilling tests in the state. This continues to show a slight decline in the activities of the state.

Both rotary and cable tools are used in New Mexico, with the former predominating in number. Rotaries are used primarily in the southeastern section of the state, where producing horizons are around 4000 feet and upper heavy pressure gas horizons are frequently encountered.

MICHIGAN

Production, 1931—3,730,000 Barrels



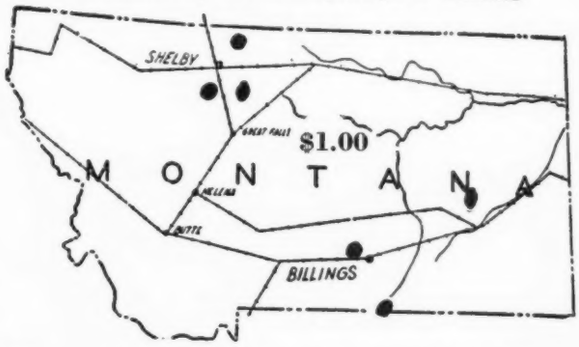
The state of Michigan had 7 tests completed in the month of January, while 44 rigs and locations and 86 drilling wells were listed on the state's activity report at the close of the month.

Operators of this state do their drilling with cable tools, except in a few instances where rotary tools have been used.

● Denotes oil and gas fields.

MONTANA

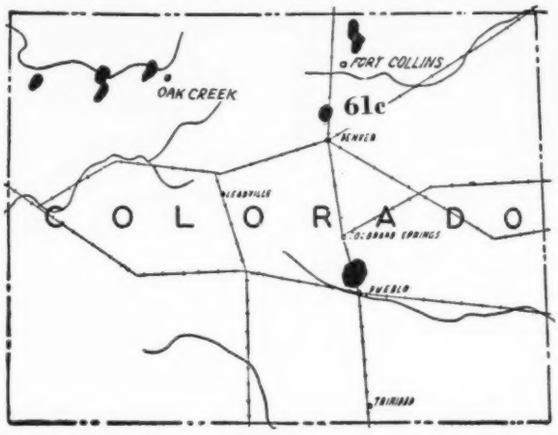
Production, 1931—2,855,000 Barrels



Montana had 3 completions, 16 rigs and 55 drilling tests for its month's activity. Cable tools are the most common means of making hole in the state.

COLORADO

Production, 1931—1,510,000 Barrels



This state had 1 completion, 13 rigs and 70 drilling tests at the close of January. Both rotary and cable tools are used for drilling purposes in the state.

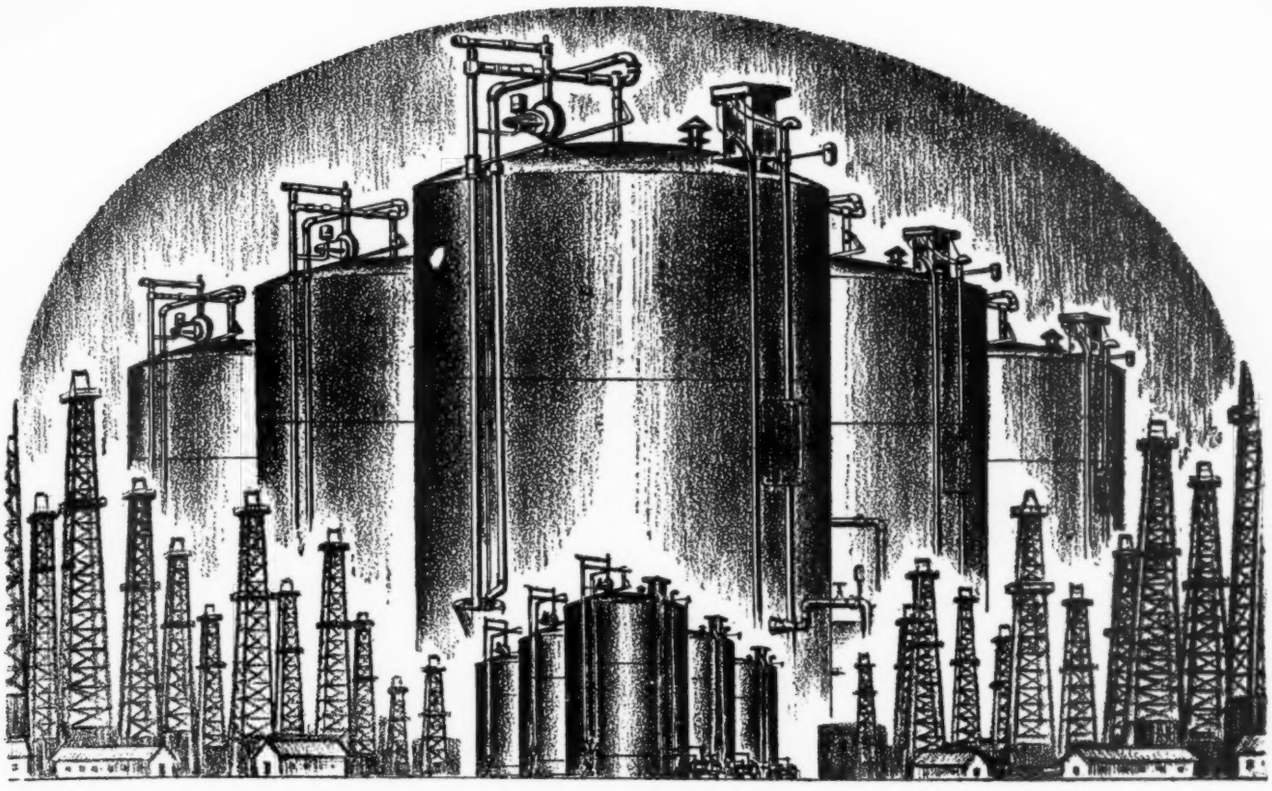
INDIANA

Production, 1931—830,000 Barrels

There were 8 oil tests completed in Indiana during January. Other oil field activity was comprised of 4 rigs and 54 drilling tests.

Standard tools are the most common means of reaching the shallow producing horizons, which offer no perplexing drilling problems in reaching.

Figures on maps indicate average prices of crude oil per bbl.



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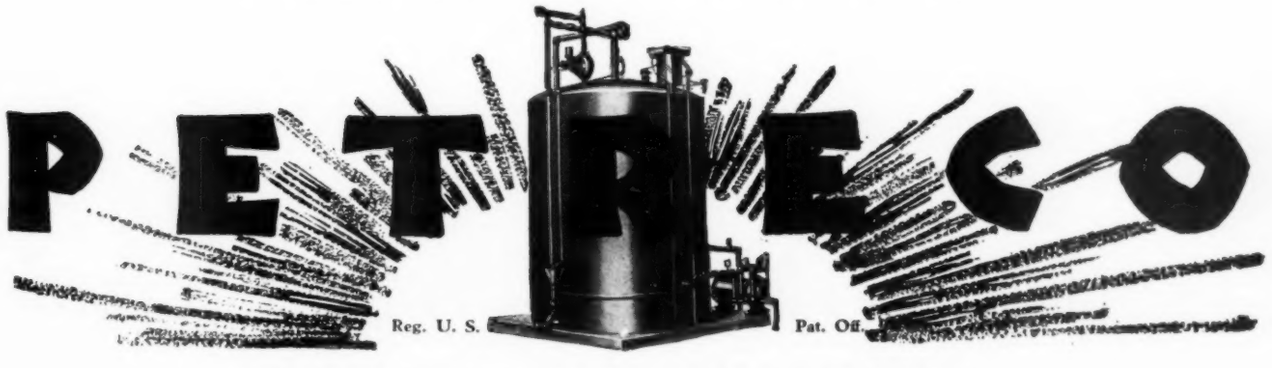


The Electrical Process of Dehydrating Crude Oil Emulsions

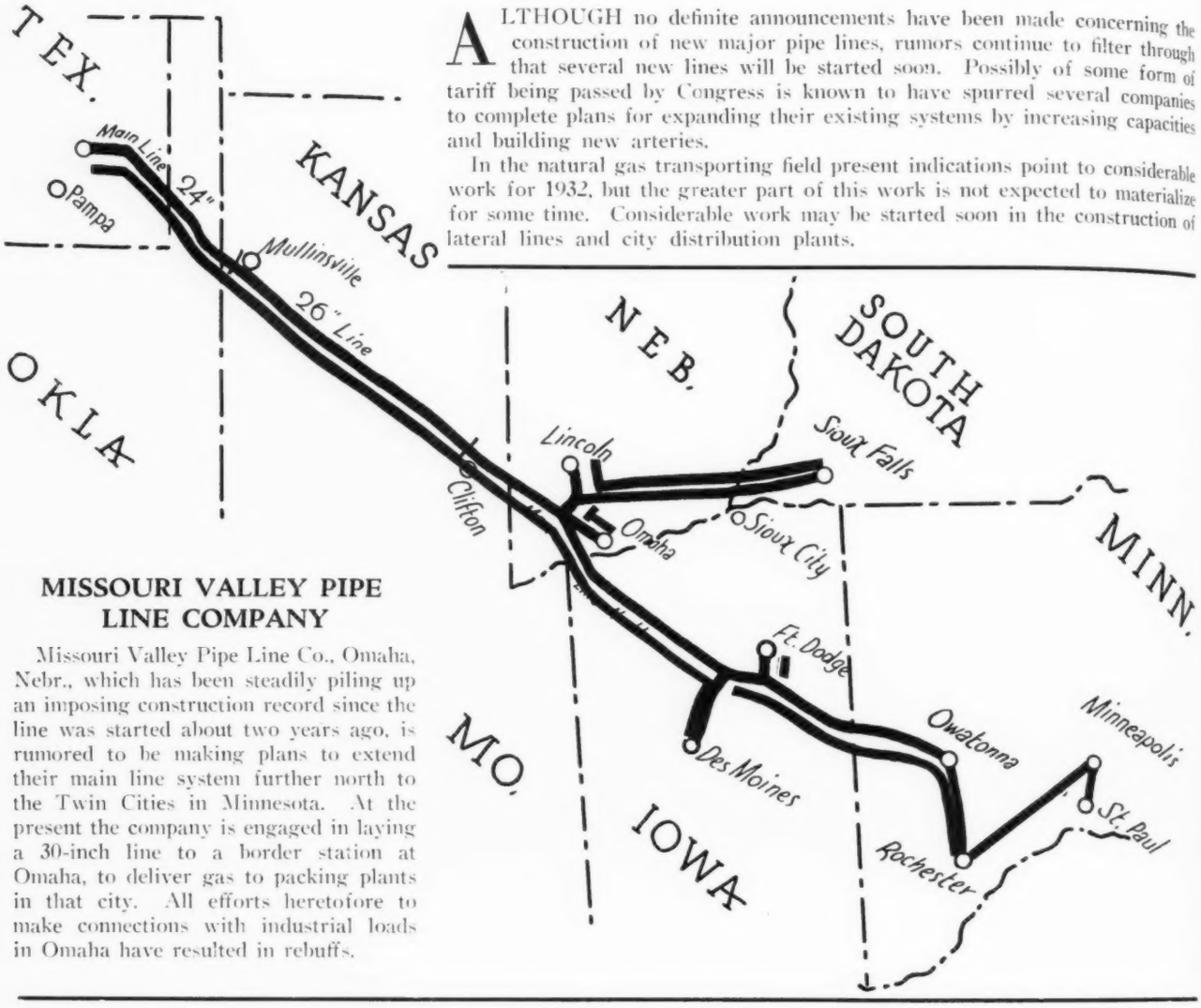
(Fully covered by process and apparatus patents.)

Progress of Major Pipe Line Work

By **J. H. DAMERON**

ALTHOUGH no definite announcements have been made concerning the construction of new major pipe lines, rumors continue to filter through that several new lines will be started soon. Possibly of some form of tariff being passed by Congress is known to have spurred several companies to complete plans for expanding their existing systems by increasing capacities and building new arteries.

In the natural gas transporting field present indications point to considerable work for 1932, but the greater part of this work is not expected to materialize for some time. Considerable work may be started soon in the construction of lateral lines and city distribution plants.

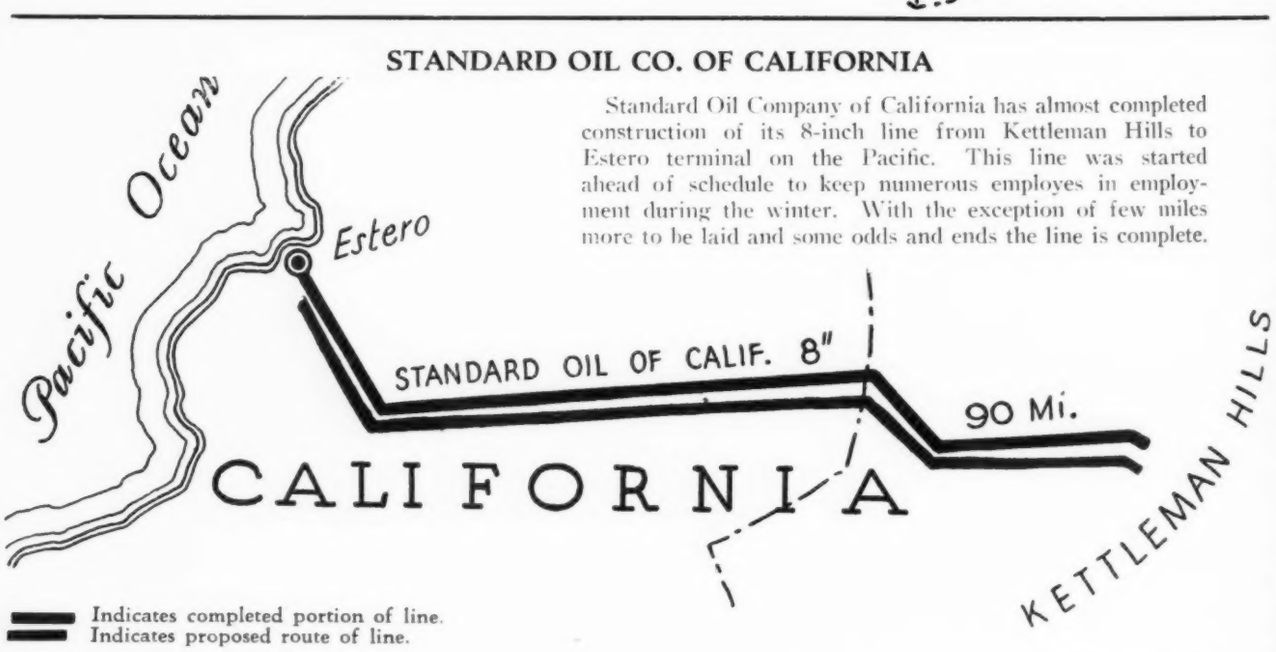


MISSOURI VALLEY PIPE LINE COMPANY

Missouri Valley Pipe Line Co., Omaha, Nebr., which has been steadily piling up an imposing construction record since the line was started about two years ago, is rumored to be making plans to extend their main line system further north to the Twin Cities in Minnesota. At the present the company is engaged in laying a 30-inch line to a border station at Omaha, to deliver gas to packing plants in that city. All efforts heretofore to make connections with industrial loads in Omaha have resulted in rebuffs.

STANDARD OIL CO. OF CALIFORNIA

Standard Oil Company of California has almost completed construction of its 8-inch line from Kettleman Hills to Estero terminal on the Pacific. This line was started ahead of schedule to keep numerous employes in employment during the winter. With the exception of few miles more to be laid and some odds and ends the line is complete.



Indicates completed portion of line.
Indicates proposed route of line.

26-IN. LINE LINDEWELDED *at a daily speed of* 14 JOINTS PER MAN . .

ON a 26-in. California natural gas line, each welder averaged 12 to 14 Lindewelded joints a day, in spite of scorching heat and rough mountain country. Every joint tested strong and tight.

This record is by no means exceptional for this Process.

Lindewelding has made a saving in welding speed of from 30 to 60 per cent. on thousands of miles of pipe line and has reduced the consumption of welding material 35 to 40 per cent.

Lindewelding can be done with ordinary blowpipes or with special apparatus which makes welding almost automatic and further increases its speed. Experienced welders quickly master this new method of oxy-acetylene welding; beginners learn it more readily than other methods.

For pipe line builders who want greater speed at lower cost, Linde Process Service has developed procedure controls for Lindewelding. These are offered to all Linde customers without charge. Our nearest district office will be glad to give you all the details.

See Every step in making a Lindewelded Joint

Lindeweld technique differs from neutral flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. Our motion picture, "The Lindeweld Process for Pipe Line Construction," shows the actual steps in making a Lindewelded joint. Pipe line officials and welding or engineering societies may borrow this picture free of charge. It is furnished in 16 mm. and 35 mm. safety film and can be obtained by writing to any Linde District Office.

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Cleveland	Milwaukee	Seattle
Denver	Minneapolis	Tulsa

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LYCOMING NATURAL GAS CORPORATION

Winding up construction work on its main line the Lycoming Natural Gas Corp., builders of a 20-inch coupled line from the Tioga area to Syracuse, N. Y., is ready to start deliveries to a distributing company at the terminal. While not verified the Lycoming Corp. is reported planning expansion of its new system.

STANDARD OIL CO. OF NEW YORK

Arkansas Pipe Line Co., Shreveport, La., has leased an 8-inch line built by the Texas Pipe Line Co. and running from Shreveport to the Gulf Coast and is using the line to ship gasoline south. The line is being re-conditioned in spots where necessary and washed so that a clean product may be shipped. The line was formerly used to transport North Louisiana and Arkansas crude to the Coast.

Indicates completed portion of line.
Indicates proposed route of line.

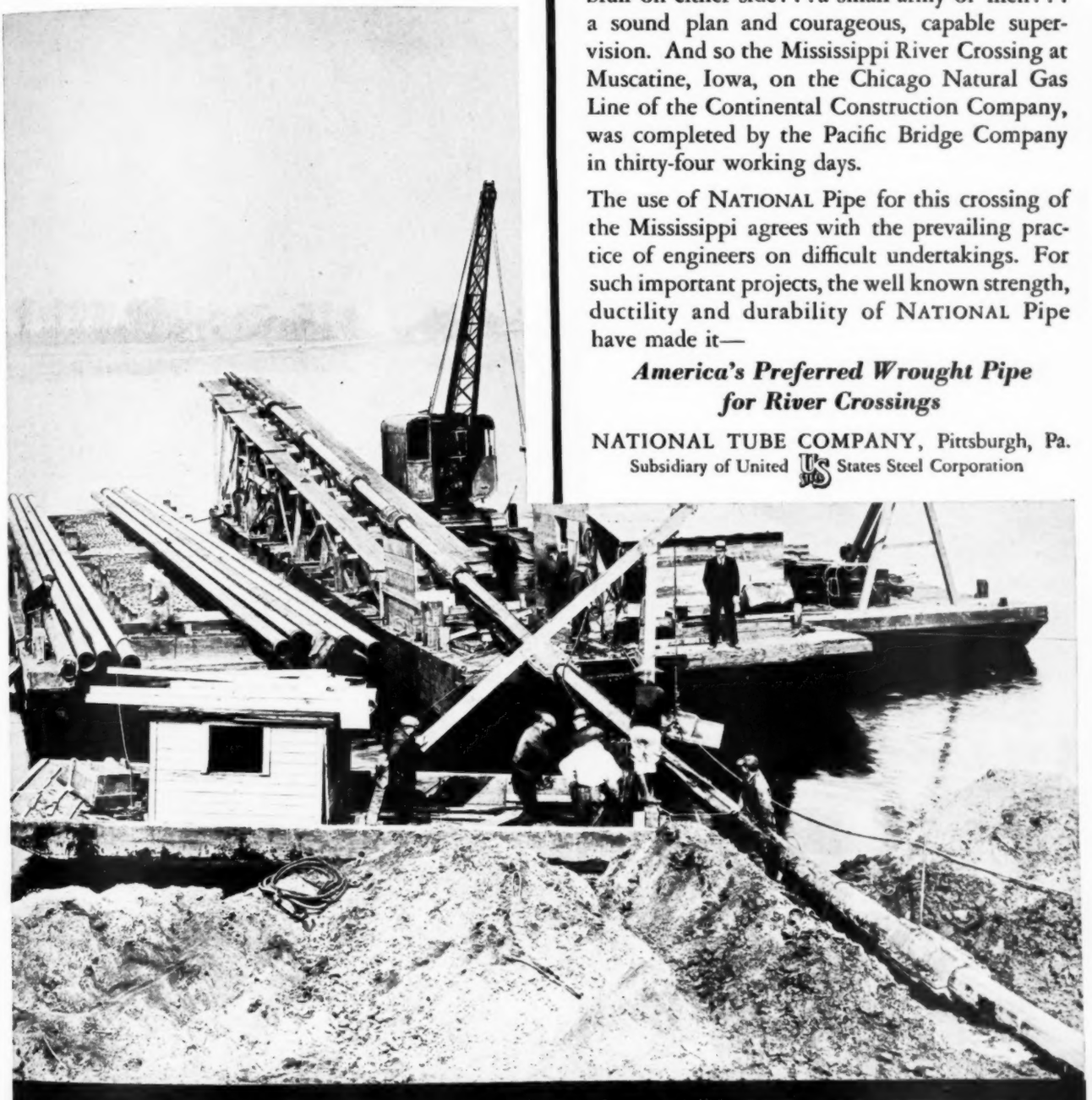
Why good time was made in laying this MISSISSIPPI CROSSING

A dredge . . . several launches . . . three barges . . . about 2400 feet of 12-inch NATIONAL Pipe for each of six lines reaching from shore to shore . . . suitable river clamps for welded joints . . . valves and headers to gather together the six 12-inch pipes at each end, terminating in two 18-inch lines . . . enough 18-inch NATIONAL Pipe to extend, double, from the water's edge to the bluff on either side . . . a small army of men . . . a sound plan and courageous, capable supervision. And so the Mississippi River Crossing at Muscatine, Iowa, on the Chicago Natural Gas Line of the Continental Construction Company, was completed by the Pacific Bridge Company in thirty-four working days.

The use of NATIONAL Pipe for this crossing of the Mississippi agrees with the prevailing practice of engineers on difficult undertakings. For such important projects, the well known strength, ductility and durability of NATIONAL Pipe have made it—

America's Preferred Wrought Pipe for River Crossings

NATIONAL TUBE COMPANY, Pittsburgh, Pa.
Subsidiary of United States Steel Corporation



NATIONAL PIPE

PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
Ga.L.	Atlantic Refg. Co.	Philadelphia, Pa.	Point Breeze	Wilkes-Barre, Pittsburgh	6-8"	475	Part of system operating. Plan extension of main line this year.
G. L.	Bivens, C. E., et al.	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932.
G. L.	Big Bend Pipe Line Co.	Ft. Stockton, Tex.	(See Remarks)				Plan to extend present system with 60 miles of 4-inch.
G. L.	Columbia Gas & Elec. Co.	New York, N. Y.	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Point in Ill.	Milwaukee, Wis.	20"	160	Buying right of way.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Texas Panhandle	Chicago, Ill.	24"	1000	Plan to start parallel present line in 1932.
O. L.	Continental Oil Company	Ponca City, Okla.	Greasewood Flats, Colo.	Denver, Colo.	6"	70	Proposed—Held in abeyance.
G. L.	Cities Service, Insull, Texas Corp. & S. O. N. J.	(See Remarks)					Rumored considering building 1,500-mile project from Panhandle to Eastern cities.
Ga.L.	Great Lake Pipe Line Co.	Kansas City, Mo.	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Plan to loop and add 3 units to each sta. or build automatic booster station.
O. L.	Gulf Pipe Line Co.	Tulsa, Okla.	Tulsa, Okla.	Spencerville, Ohio	10"		Plan looping present line and increasing station capacity.
G. L.	International Util. Corp.	New York, N. Y.	Alberta, Canada	Vancouver, B. C.	20"	500	Proposed.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo.	Seattle, Wash.	20"	500	Proposed.
G. L.	Lycoming Nat. Gas. Corp.	New York, N. Y.	Tioga Field, N. Y.	Syracuse, N. Y.			Plan to extend main line from Syracuse to Oswego with 38 miles of 16-inch.
G. L.	Lewiston Nat. Gas Co.	Lewiston, Mont.	Armells Structure, Mont.	Mont. towns	4-6"	100	Proposed.
G. L.	Missouri Valley P. L. Co.	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed.
O. L.	Magnolia P. L. Co.	Dallas, Tex.					Mid-Continent to Eastern connections; 12-inch. Rumored.
G. L.	Montana-Dakota Power Co.	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co.	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co.	San Francisco, Calif.					Have appro. for $2,000,000 expansion campaign.
G. L.	Panhandle Eastern P. L. Co.	Kansas City, Mo.	(See Remarks)				Reported planning 200 miles of lateral line construction in Missouri and Illinois.
Ga.L.	Phillips Pipe Line Co.	Bartlesville, Okla.	Texas Panhandle	St. Louis, Mo.	8"		Plan to build 4 booster sta. and build 50 miles of line.
O. L.	Stanolind Pipe Line Co.	Tulsa, Okla.	Mid-Continent	Chicago, Ill.	8-10"	360	Looping 360 mi. of existing line and increasing station capacity, looping complete.
Ga.L.	Sun Pipe Line Company	Philadelphia, Pa.	Point in N. Y.	Lake Ontario	6"	45	Extending to tidewater terminal.
G. L.	Southern Nat. Gas Corp.	Birmingham, Ala.	(See Remarks)				Reported planning extension to Chattanooga, Tenn.
O. L.	Texas Empire Pipe Line Co.	Tulsa, Okla.	Okla. City, Okla.	East Texas	10-12"	250	Pur. right of way for oil line to East Texas pipe inquiry out.
O. L.	Tex-York Utilities Corp.	New Orleans, La.	East Texas	New Orleans, La.	8"	400	Proposed.
G. L.	United Public Service Co.	Houston, Texas	Austin	Wichita Falls	20"	240	Rumored plan extension of main line system.
Ga.L.	White Eagle Oil Co.	Augusta, Kan.	Augusta, Kan.	Kansas City Mo.	8"		Considering construction of Gasoline line.
G. L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.
O. L.	Yount-Lee Oil Company	Beaumont, Tex.	High Island	Spindletop	10"	45	Building oil outlet to Spindletop storage.
O. L.	Texas Royalty Owners & Producers P. L. Co.	Tyler, Texas	East Texas	Houston, Texas	12"	200	Applied to Texas "Blue Sky" Commissioner for permission to sell stock.

TABLE

O. L.—oil line Ga. L.—gasoline line
G. L.—gas line

UNIFORM WALL THICKNESS *the full length*

UNIFORM WALL THICKNESS is an outstanding feature of all "STANDARD" SEAMLESS Steel Pipe . . . It is your guarantee of uniform strength, safety and dependability . . . A seamless pipe in which you can place the utmost confidence.

STANDARD

SEAMLESS STEEL PIPE

SPANG, CHALFANT & CO., INC.

General Offices:

Clark Building, Pittsburgh, Pa.

Sales Offices: New York, Boston, Pittsburgh, Chicago, St. Louis, Tulsa, Los Angeles, Dallas, San Francisco

Welded Mills: Etna, Penna., Sharpsburg, Penna.

Seamless Mills: Ambridge, Penna.

The Month's Activities *in* Refining*

By F. R. STALEY

REFINERS in all divisions made further reductions in crude throughput during the past month.

The Continental Oil Company is installing new screening and conveying equipment to handle petroleum coke at Ponca City. Additional anhydrous ammonia storage is being erected to take care of tank car receipts of this material.

The Coastal Petroleum Corporation is scheduled to start operations early this month. Distillation equipment was furnished by J. P. Devine Manufacturing Company, Inc. It is a combination skimming and viscosity-reducing unit for East Texas crudes, and is equipped with a tower on which three grades of gasoline cuts are simultaneously produced, together with a kerosene stream.

The J. P. Devine Manufacturing Company designed the accessory equipment necessary to form a complete 6,000-barrel daily capacity unit, which was erected on Blakley's Island in Mobile Bay.

The new cracking unit of 1,250 barrels charging capacity at Bradford, Pa., is producing gasoline above 75 octane number from Pennsylvania gas oil. This unit was built for the Kendall Refining Company by the Arthur G. McKee Company of Cleveland, Ohio.

Federal Oil & Refineries, Ltd., will build a small plant at St. John, N. B.

Rio Oil & Gas Company will build a 350-barrel plant at Rio Grande, Texas.

Arthur G. McKee & Co., through Schneider et Cie, Paris, has been awarded the initial contracts in connection with a $15,000,000 oil refinery project in France. The contract for primary crude distillation equipment is for a total of 15,000 barrels per day of crude, this to be processed in two 7,500-barrel-per-day distillation units.

The Somerset Refining Company will build a small refinery at Somerset, Ky.

Operations were started at the new 1,000-barrel refinery at Bowling Green, Ky., by the Bowling Green Refining Company. George McGinley is president of the company. The plant was designed and built by the Leader Iron Works, Inc.

By-products of petroleum and natural gas were discussed at the January meeting of the American Chemical Society, Oklahoma petroleum section, in Tulsa. Dr. Sidney Born presented a paper on alcohol production and other synthetics from petroleum.

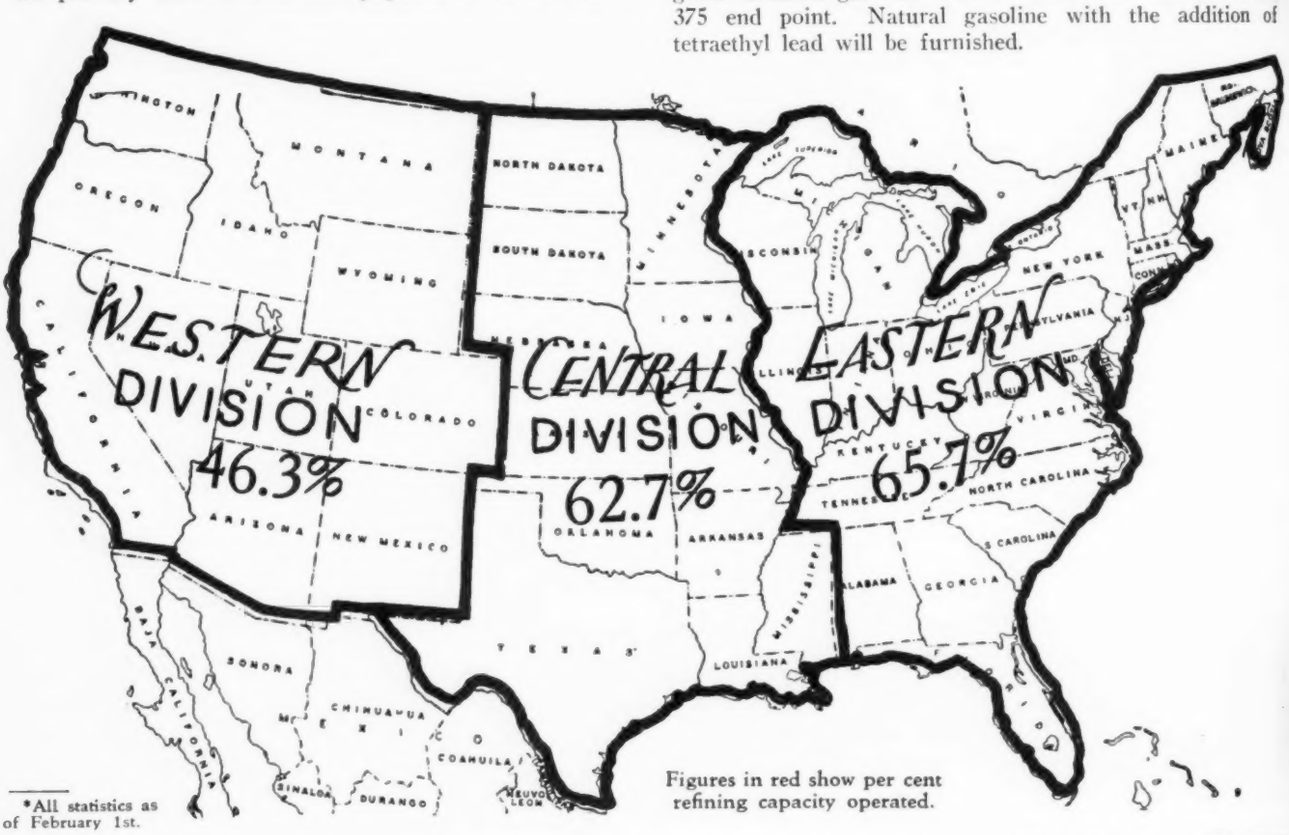
A number of important papers on motor fuels and lubricants were presented at the annual meeting of the Society of Automotive Engineers, January 25-29 in Detroit.

Classifications for free-wheeling lubricants were discussed in Washington, D. C., January 21-22, at a joint session of Committee D-2, A. S. T. M.; Specification Committee of the refining division A. P. I.; and the S. A. E. lubricants division.

Natural Gasoline

Twenty-four representatives of the Shell Petroleum Corporation's gasoline department met at Ponca City, January 15th, to discuss operating and safety problems. They were from the states of Oklahoma, Texas and Kansas. S. S. Smith, general manager of the department, presided.

The Phillips Petroleum Company has been awarded a large contract by the U. S. Army Air Corps for fighting grade aviation gasoline with an octane number of 87 and 375 end point. Natural gasoline with the addition of tetraethyl lead will be furnished.



Figures in red show per cent refining capacity operated.

*All statistics as of February 1st.

The IDEAL Seamless Pipe TURN

ADVANTAGES OF CREASED TURNS:—

ONE—Tangents may be of any desired length at either end from a minimum equal to the nominal diameter of the pipe to a maximum governed only by the commercial lengths of pipe.

TWO—The Tangents remove line welds from the location of compound stresses due to expansion.

THREE—CREASED TURNS are furnished to any desired angle.

FOUR—CREASED TURNS are made with radii equal to 1½, 2 and 2½ times the nominal diameter as desired.

FIVE—CREASED TURNS come with ends beveled for welding or with flanged ends.

SIX—Increased flexibility resulting in decreased anchor forces is obtained.

WRITE FOR ADDITIONAL INFORMATION.

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Casing Recovery From Cable Tool Holes

ABOUT 80 per cent of the drilling in the gas fields of Carson and Gray Counties in Texas for the Texhoma Natural Gas Co. is being done with standard tools. It is all contract drilling at approximately $2.75 per foot, the Texhoma Natural Gas Co. furnishing the rig and casing. At the beginning of the exploitation of this field there was considerable discussion as to whether the rotary system or the standard tool system could complete wells more cheaply in this particular area.

In this district approximately 1000 feet of unconsolidated sands and 1100 feet of salt rock must be drilled before encountering the gas zone. The sand formation is water-bearing and is so loose that it caves around the casing, often tight enough to prevent its subsequent removal. One of the operators in this field who recently had had experience with the treatment of rotary drilling mud conceived the idea that if a viscous collodial mud were placed between the casing and the formation, the sands would be prevented from seizing the casing firmly enough to interfere with its removal. A mud was prepared in the proportions of 15 pounds of Aquagel per barrel of water and poured into the space between the casing and the wall of the hole at the rate of two barrels per joint of pipe during the time that the casing was being run in. In addition to this, another assurance was had that the wall of the hole would be rendered less abrasive. Into each bailer of drilling water was placed 15 pounds of dry Aquagel. The motion of the tools mixed the Aquagel with the water and the finer cuttings and coated the formation with a slimy mud which greatly facilitated the running in of casing. One to two tons of Aquagel was sufficient to assure a viscous mud behind all casing in the hole. When the production string was cemented, the preliminary casings were pulled from the hole with no trouble at all. Table A shows a casing report on four wells drilled by this operator; two wells used no Aquagel and two wells had been treated with Aquagel in the foregoing manner.

The results of the field tests (below) were so conclusive that the field office of this company recommended that the casing in all subsequent standard tool wells be protected with an Aquagel-water mud. In view of the fact that the Texhoma Natural Gas Co. purchases all preliminary casing, this company now furnishes Aquagel free of charge to all contractors to insure their maximum recovery of casing. Since the time of the initial application of this practice to cable tool holes, there have been forty wells drilled in this district, thirty-nine of which have a record of 100 per cent casing recovery. The usual program for preliminary casing is:

350 feet of 15½-inch A. P. I. Standard
600 feet of 12½-inch A. P. I. Standard
900 feet of 10 -inch A. P. I. Standard

This casing represents a value in excess of $4,600 and the expenditure of as little as $100 for Aquagel has thus far assured a forty-to-one chance that all casing will be recovered in good order.

TABLE A

FIELD REPORT ON USE OF AQUAGEL IN CABLE TOOL WELLS

WELLS USING AQUAGEL

Well—Burnett No. 29 A
Carson County, Texas

Size Casing	Run	Unrecovered
20 -inch	121 feet	None
15½-inch	280 feet	None
12½-inch	813 feet	None
10 -inch	1287 feet	None

Total time pulling casing—24 hours

Well—Frashier No. 1
Gray County, Texas

Size Casing	Run	Unrecovered
15½-inch	285 feet	None
12½-inch	537 feet	None
10 -inch	1243 feet	None

Total time pulling casing—36 hours

WELLS USING NO AQUAGEL

Well—Jordan No. 1
Carson County, Texas

Size Casing	Run	Unrecovered
20 -inch	141 feet	102 feet
15½-inch	367 feet	286 feet
12½-inch	552 feet	None
10 -inch	1074 feet	None

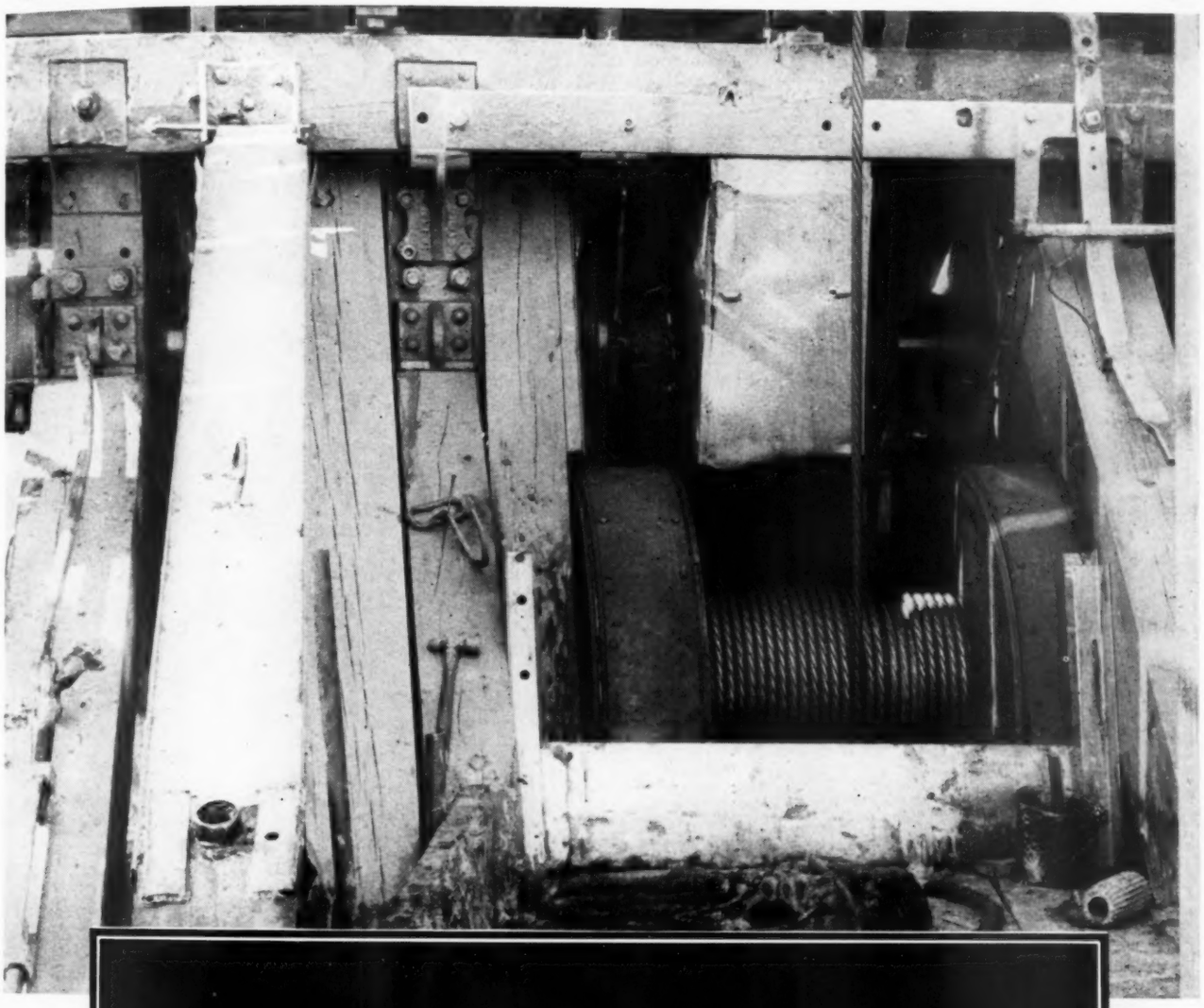
Total time pulling casing—57 hours

Well—McConnell No. 1
Carson County, Texas

Size Casing	Run	Unrecovered
15½-inch	380 feet	380 feet
12½-inch	729 feet	250 feet
10 -inch	911 feet	296 feet

Total time pulling casing—240 hours

American
WIRE LINES



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INTERNATIONAL SUPPLY STORES

• Kendall
Operating New

Gray Tower installation for vapor phase treating of gasoline from new Dubbs unit at Kendall Refinery, Bradford, Pa.

THE Kendall Refining Company, Bradford, Pa., has recently completed and put into operating a new cracking unit having a daily charging capacity of 1,250 barrels. This company was the second refiner of Pennsylvania grade crude to install the Dubbs process, having installed two units in 1924. Three other refineries in this area have recently completed similar units, the Emlenton Refining Company,[1] the Ohio Valley Refining Company, and the Pennzoil Company.

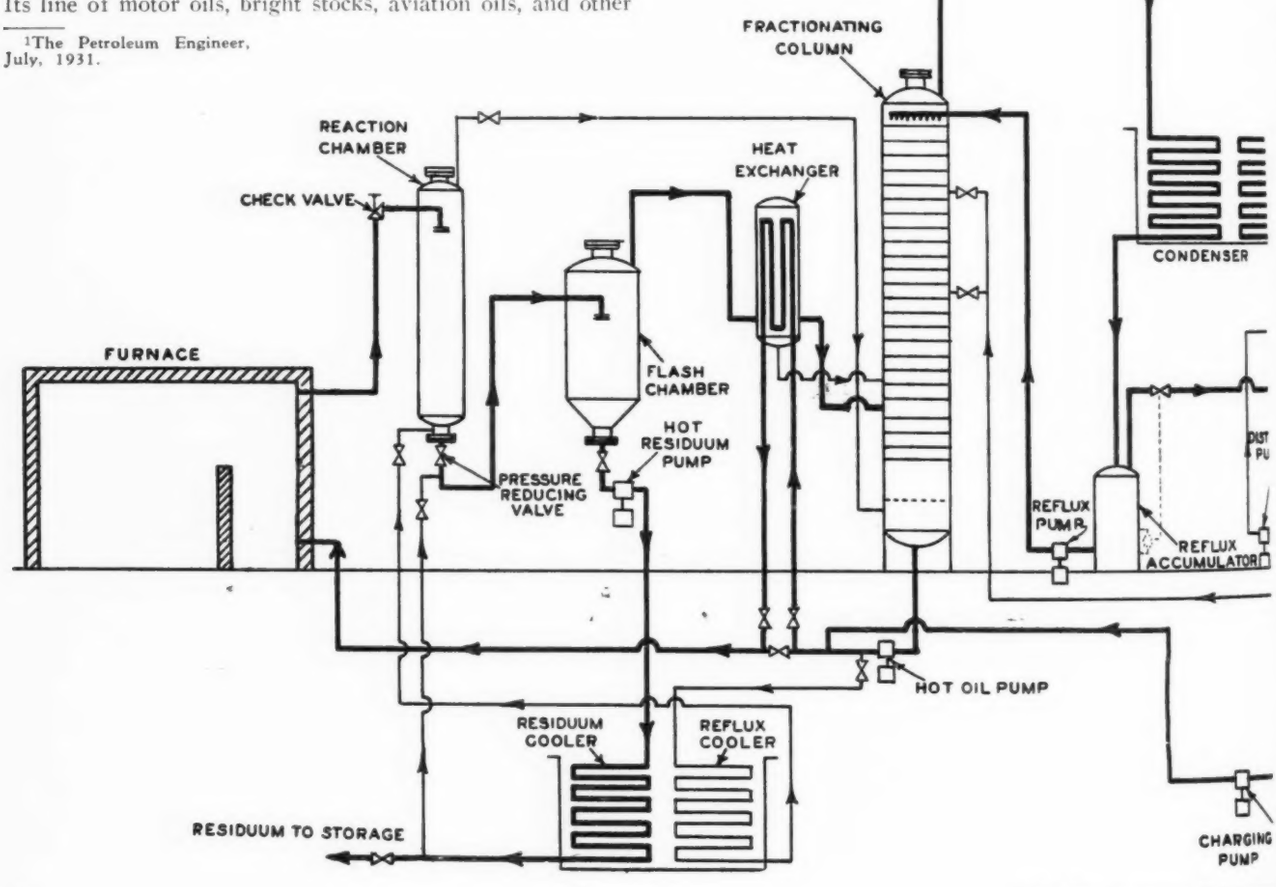
The Kendall refinery processes only Bradford grade crude. Its line of motor oils, bright stocks, aviation oils, and other lubricants have long been known for their excellent quality. The construction program recently completed at this refinery makes it one of the most modern and complete both from the standpoint of lubricating oil and high quality anti-knock motor fuel manufacture. In addition to the new cracking unit a new testing and research laboratory and a new distillation unit were built.

The new cracking unit embodies the latest developments in refinery engineering. It is producing a high quality motor fuel testing above 76 octane number from Pennsylvania gas oil. The unit will crack gas oil or kerosene or reform straight run naphthas and gasoline.

[1]The Petroleum Engineer, July, 1931.

Gray Vapor Phase Process

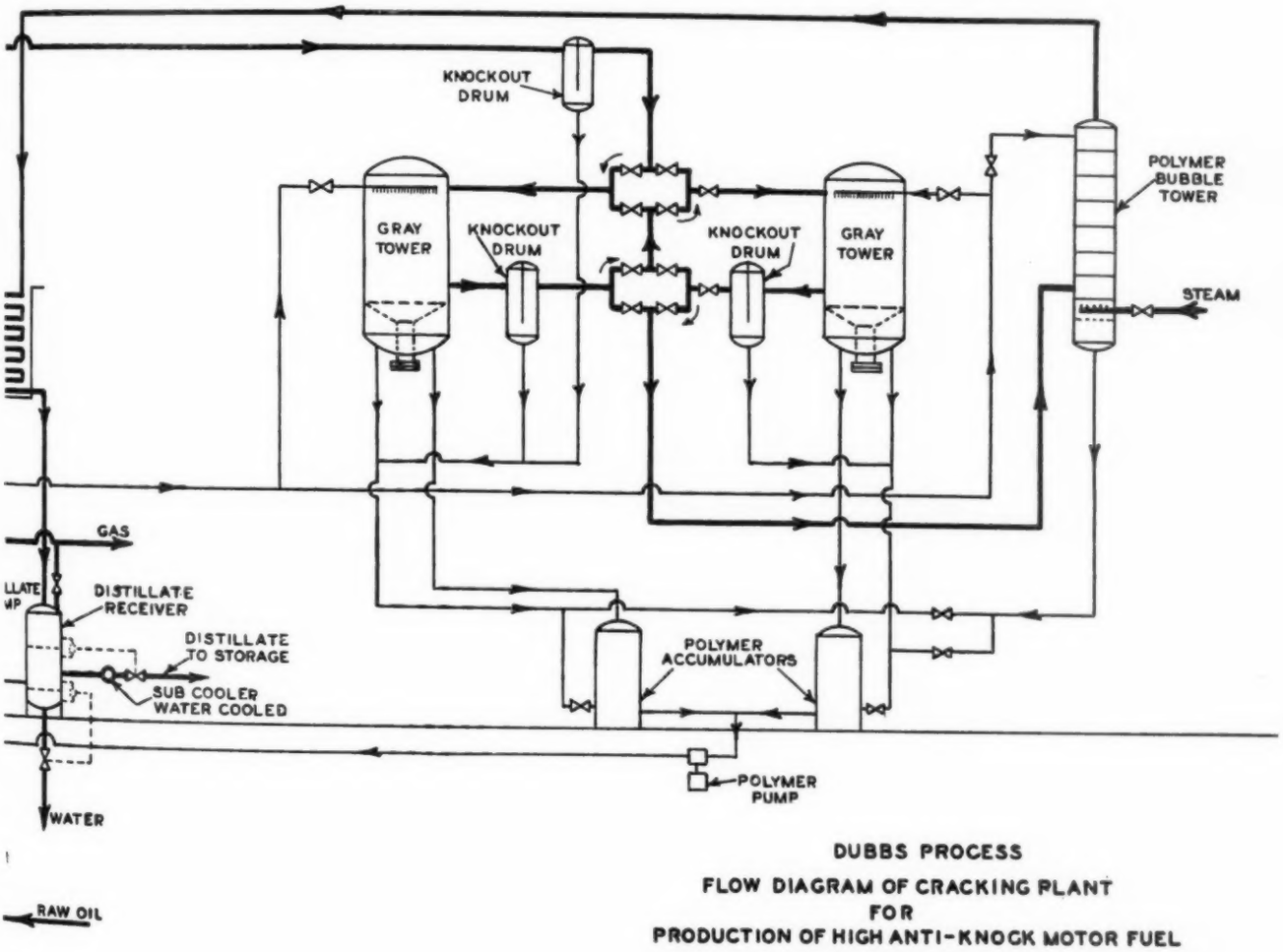
The motor fuel produced by the new unit is treated in the vapor phase by means of two Gray towers which operate in direct connection with the unit.



Refinery
Cracking Unit

Dubbs Cracking Unit at Kendall Refinery showing Alcorn Furnace on left.

The installation is shown in the photograph. During the past year the number of Gray tower installations has increased rapidly. The process is operating successfully in direct connection with Cross, Dubbs, Jenkins, and other types of cracking units. It produces a non-gumming motor fuel without decreasing the octane number. The high anti-knock rating of the cracked gasoline is preserved. Some of the other advantages of vapor phase treating are the elimination of acid, rerunning, and the disposal of acid sludge. Usually valuable anti-knock compounds are removed with acid from cracked or reformed gasoline. Treating costs and losses are minimized by direct vapor phase treating; the total cost including royalty, depreciation, labor, treating material, and all other costs is usually below eight cents per barrel of finished gasoline. The flow diagram shows the



DUBBS PROCESS
FLOW DIAGRAM OF CRACKING PLANT
FOR
PRODUCTION OF HIGH ANTI-KNOCK MOTOR FUEL
WITH GRAY VAPOR PHASE TREATING EQUIPMENT

Where Knock Rating Is a Problem

Pennsylvania refiners, handicapped by the low octane number of their gasoline, are installing modern equipment to improve this quality.

In recent months four of them have selected Vapor Phase Refining to preserve the knock rating which their cracking and reforming units give them. In this way they know they will get a non-gumming, colorless, completely refined motor fuel with an octane number at least as high

Vapor Phase Refining Helps Answer It

as that of the raw cracked product—and at a low cost.

These plants are already in operation. They show the refiners' faith in Vapor Phase Refining is more than justified.

Whatever your crude, whatever your cracking units, our process can help you.

THE GRAY PROCESSES CORPORATION

961 - 975 FRELINGHUYSEN AVENUE

NEWARK, NEW JERSEY

layout of the Gray vapor phase treating process operating in direct connection with the Dubbs unit.

Alcorn Furnace

An Alcorn furnace is installed with the cracking unit at the Kendall refinery. This type of furnace is installed at Emlenton, Pa., and at St. Mary's, W. Va., on Dubbs units. The Alcorn Combustion Company developed the radiant heat furnace as the most effective means of heating oil in cracking coils; radiant and convection heat are separately applied to different parts of the absorbing structure in the furnace.

Some of the outstanding advantages of this type of furnace are the constant heat-input curve to the oil; its flexibility and efficiency in cracking a wide variety of charging stocks; a maximum capacity for a minimum furnace volume and effective tube surface, which results in a low maintenance and replacement cost. The heat input per square foot of effective tube surface is practically constant in the principal heating elements of the furnace. One of the exclusive features of the Alcorn form is the use of floor tubes for the absorption of radiant heat only.

The Dubbs unit at the Kendall Refinery was built by the Arthur G. McKee & Company, engineers of Cleveland, Ohio, at the cost of $350,000.

All Cracked Gasoline

The ever-increasing demand for anti-knock gasoline required by the high compression automobile engines has greatly stimulated the construction of cracking units, since cracking produces motor fuels possessing these properties. Straight run gasoline and naphtha can be cracked in order to raise their octane numbers or anti-knock rating. It is not necessary to use a special unit to crack these light fractions, since the new units can crack any fraction of the crude, whether light or heavy, producing high octane gasoline.

A special low royalty rate has been announced by the owners of the Dubbs process for cracking straight run gasoline or naphtha to improve the anti-knock value. This low rate applies also to fractions in the crude or other charging stock of a specified boiling range. This new rate will undoubtedly extend the use of cracking. It is now possible and economical for a refiner to produce only gasoline having a sufficiently high anti-knock rating to meet the market demands, thus eliminating unnecessary storage costs or being penalized for low quality.

The table shows the yields and the octane numbers of the cracked gasoline produced from various crudes, fuel oil, gas oil, kerosene, and naphtha.

Cracking has become one of the most important methods of producing modern motor fuels, and the percentage of cracked gasoline produced in the United States has steadily increased, while that of straight run has shown a decrease the past two years.

OCTANE NUMBERS AND PERCENTAGE YIELDS OF CRACKED GASOLINES*

Charge	A. P. I. Grav. of Charge	Cracked Gasoline Per Cent of Charge	Cracked Gasoline Octane Number	Cracked Fuel Oil, Per Cent	Gas and Loss, Per Cent
Crude Oils:					
Refugio, Texas	23.2	53.0	91	31.7	15.3
Santa Fe Springs	32.8	63.6	77	24.7	11.7
Joiner, Texas	37.9	69.4	70	22.6	8.0
Oregon Basin	23.2	47.6	75	49.1	3.3
Lost Soldier	29.4	59.9	79	35.7	4.4
Egbell, Czech	19.7	55.9	89	36.5	7.6
Hodonin, Czech	23.6	61.0	86	29.2	9.8
Nienhagen, Germany	26.6	57.4	75	34.1	8.5
Edessa, Germany	34.5	68.8	73	20.7	10.5
Gasoline and Naphtha:					
Pennsylvania	58.7	83.7	76	5.4	10.9
Pennsylvania	52.7	84.4	76	4.8	10.8
Kerosene:					
Pennsylvania	46.1	81.2	75	8.5	10.7
Mid-Continent	39.1	69.2	81	11.7	19.1
West Texas	36.4	65.4	89	13.2	21.4
California	38.3	74.6	77	9.3	16.1
Santa Fe Springs	35.4	67.7	78	17.7	14.6
Syria	32.7	56.8	73	27.1	16.1
Gas Oils:					
Mid-Continent	35.3	65.2	80	15.1	19.7
Coastal	28.5	61.0	90	18.3	20.7
Fuel Oils:					
Mid-Continent	24.3	56.4	76	37.6	6.0
Oklahoma City	30.6	66.5	74	27.8	5.7
Kansas	26.2	61.0	75	29.0	10.0
Van Zandt, Texas	24.3	61.8	71	32.3	5.9
East Texas	27.1	57.5	71	37.0	5.5
Joiner, Texas	27.6	53.9	74	35.4	10.7
Pettus, Texas	36.7	69.6	73	13.8	16.6
California	17.8	38.9	79	61.0	0.1
Santa Fe Springs	19.8	40.9	75	51.3	7.8
Kettleman Hills	28.3	58.6	80	31.0	10.4
Pennsylvania	39.5	70.5	76	11.0	18.5
Kentucky	23.4	55.1	76	44.0	0.9
Lost Soldier	28.9	56.1	80	34.4	9.5
La Rosa, Venezuela	15.7	26.7	78	70.7	2.6
Lobitos, Peru	28.9	30.9	85	39.2	9.9

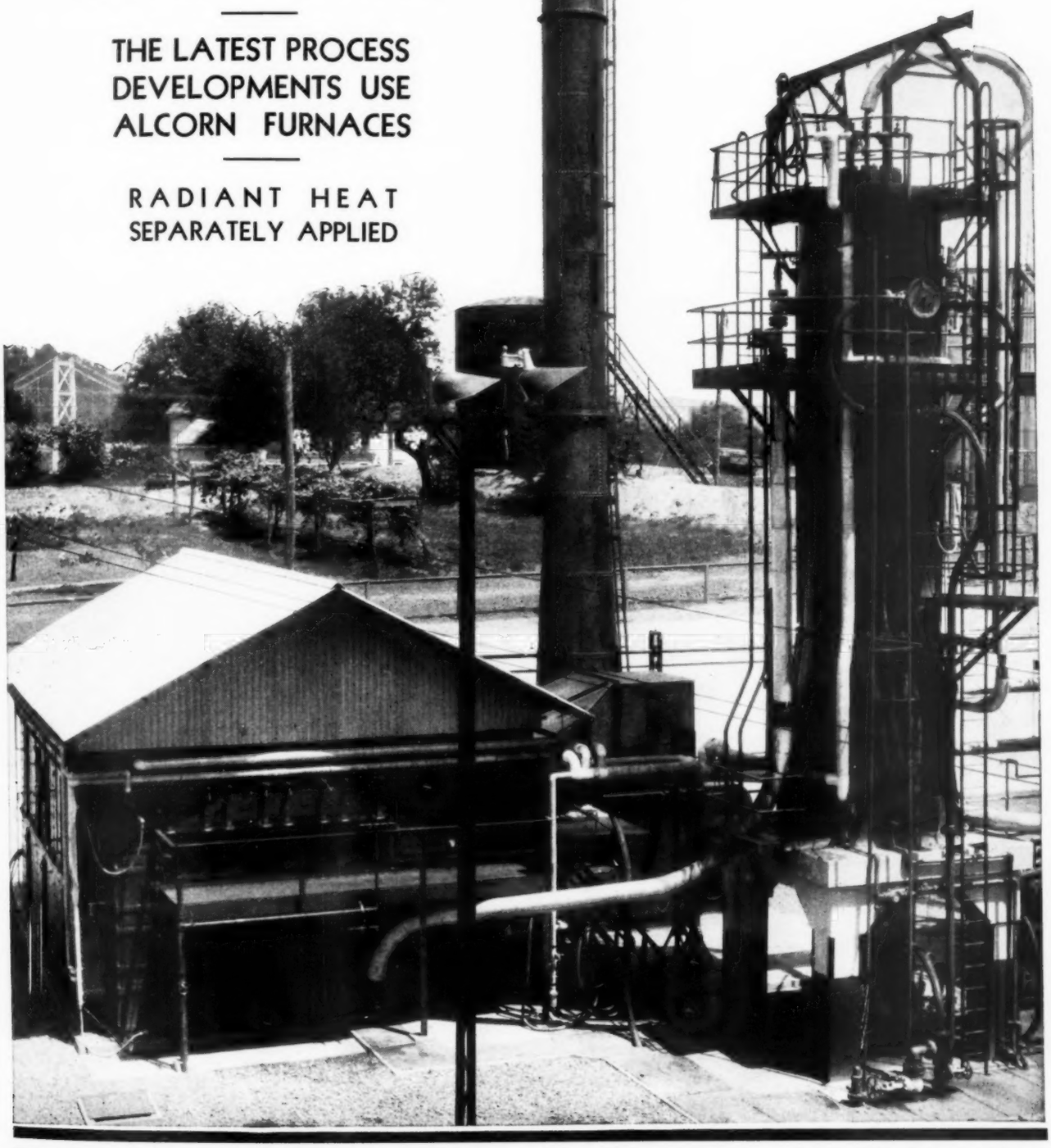
*Egloff, A. I. M. E., Feb. 18, 1932.

THE INDUSTRY DEMANDS

HIGHER OCTANES

THE LATEST PROCESS
DEVELOPMENTS USE
ALCORN FURNACES

RADIANT HEAT
SEPARATELY APPLIED



THE ALCORN COMBUSTION COMPANY

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LOS ANGELES - SAN FRANCISCO
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Pacific Abrasive Supply Co.

HOUSTON OFFICE
Petroleum Bldg.

Steel Pins Used to Hold Pipe Line Stream Crossing

IN THE construction of its 12-inch welded line from West Texas to tidewater near Houston, Texas, the Texas Pipe Line Co. encountered one of its most difficult stream crossing, the 150-foot crossing near San Marcos. To make the crossing permanent it was necessary to tie the line down with upset steel pins, set in concrete and bent over the pipe.

The bed of the stream is solid rock and during dry periods the stream is dry. Following a heavy rain the stream frequently becomes a raging torrent, sometimes rising to a depth of 30 feet.

When construction crews were about half through blasting a two-foot trench across the bed a storm caused the stream to rise. The line was rolled into the half-complete trench and the construction crews, camping at the site, were forced to climb into nearby trees to escape the rising water.

Boulders and logs, rolled downstream by the swift current, ripped the line out of the trench and carried it downstream. After the water had receded sufficiently to permit crews to resume work the trench was blasted out to a depth of two feet. In doing so the side walls of the trench were belled out at the top of the trench, sometimes to a width of four to five feet. Even with the line weighted down with 2,000-pound clamps and with a foot of covering over the pipe it remained in a precarious position during flood stage. A tree trunk being swept downstream might be plunged down into one of the wide places in the trench, snag in the pipe and rip the line out.

Cleaning ditch in river bed.

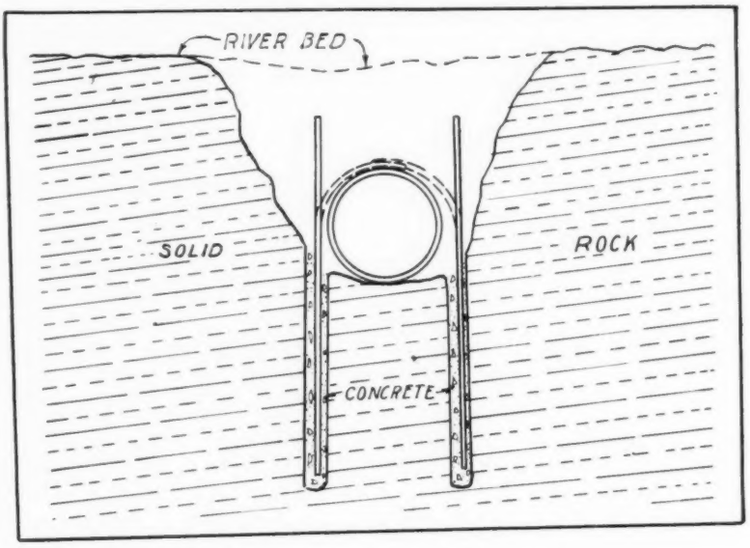

Diagram showing method of tying line down.

To make the crossing permanent it was decided to lash it down with upset steel pins, set in concrete. These were made with 1-inch steel bars cut in short lengths and upset by heating one end and battering it. Air drills were used to drill 2-inch holes spaced approximately every 20 feet on both sides of the line and near the river clamps.

The rods were set in the holes with the upset end down so the rod would set more rigidly when the concrete was poured. Water was in the stream at the time the repair was made and when the concrete was poured a piece of down spouting was used to guide the concrete. After filling each hole the rod was moved up and down in the concrete a few times to insure a better job.

After permitting the concrete to set a nearby repair crew returned and bent the rods over the pipe. The free ends were joined with cable clamps and later, when the stream permitted the cable clamps were cut and the rods electrically welded to make the job permanent.

Since tying the line down in this fashion the crossing has not given any trouble. The ditch was filled with boulders.

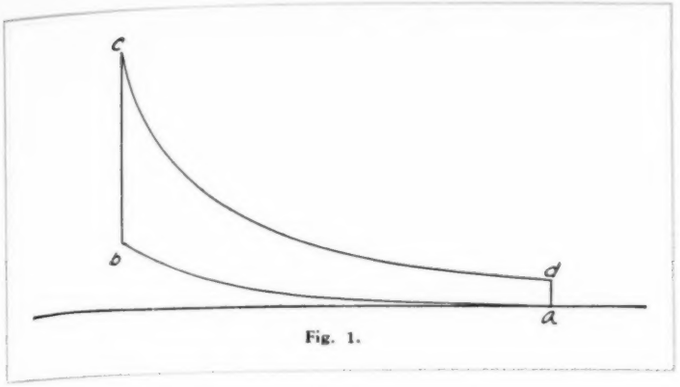

Fig. 1.

A Study of Efficiencies in Four Cycle Gas Engines

By M. V. COUSINS
United Gas Co., Bethany, La.

IN any study of efficiencies in gas engines some reference must be made to theoretical efficiencies. It must be understood that theoretical studies do not concern themselves with the practical application of a certain cycle of operation. This discussion will concern only the four-cycle gas engine, although some of the material will be applicable to other engines. These engines operate on a modification of the Otto cycle. A pressure-volume diagram of this cycle is shown in Fig. 1, the phases of which are as follows, starting at the point A:

First phase, A to B, adiabatic compression.
Second phase, B to C, heating at constant volume.
Third phase, C to D, adiabatic expansion.
Fourth phase, D to A, cooling at constant volume.

To give a more descriptive account of this possible action in an engine, at the point A the cylinder may be considered as filled with an explosive mixture of gases. From the point A to the point B these gases are compressed, by the movement of the piston, adiabatically, that is, without gain or loss of heat from the mixture in the cylinder. At the point B the mixture is fired through some agency external to the gas itself, which causes the release of energy from the gas in the form of heat, which in turn causes a rise in pressure to the point C. At the point C the gases are completely burned and their burning has caused the pressure in the cylinder to rise to its highest point. From this point the gas is expanded through a return movement of the piston to the point D, again without gain or loss of heat. Point D is the end of the stroke and from this point to point A the gases are cooled at constant volume, which causes a drop in pressure to that at the starting point.

It must be understood that the above does not represent the action that takes place in any engine, as this is impossible from a practical standpoint. It does represent the theoretical engine from which our modern four-cycle gas engines are developed. It might also be pointed out that the actions of real engines are only variations based on the above cycle, so that to obtain a measure of what should be accomplished in a practical gas engine we must have a measure of the results that might be accomplished in an engine operating on the theoretical ideal cycle. From these results we may study those variables that are necessary from a practical operating point of view and their effect on the efficiencies of an engine.

The cycle as shown in our diagram allows for no loss in any part of the cycle. The expansion is carried only to the original volume, the heat loss being entirely in the cooling of the gases from the point D to the point A. This makes the theoretical efficiency for this cycle a relatively simple calculation, since the only variable that affects the efficiency is the point to which the compression is carried—that is, the ratio of compressions. Chart 2 shows this variation and gives a good idea of the theoretical possibilities of this cycle. It will be noted that the efficiency rises very fast at first, with an increase in the ratio of compressions, but more slowly with a further increase. It is evident that the most obvious method of raising the efficiency of a gas engine is to raise the ratio of compressions. This is limited, however, by practical considerations and cannot be carried beyond certain points.

In discussing the necessary practical variations from the ideal cycle that affect an engine's efficiency, reference will be made to Fig. 3, on which the various points are designated. The ideal Otto cycle is shown in dotted outline. This cycle did not consider the necessities of taking in the charge before starting at the point A or of discharging the burned gases at D. The full line outline shows an indicator diagram as might be obtained on a four-cycle gas engine which, of course, includes the intake and exhaust cycles.

Starting at the point 1, which corresponds with the point A on the ideal Otto diagram, the cylinder is filled with an explosive mixture. It will be noticed that the point 1 is somewhat lower than the point A, due to the partial vacuum in the cylinder caused by the sucking in of the mixture. From the points 1 to 2 the mixture is compressed as from A to B on the ideal card. The actual compression cannot be adiabatic, as the cylinder walls are hot and will transfer

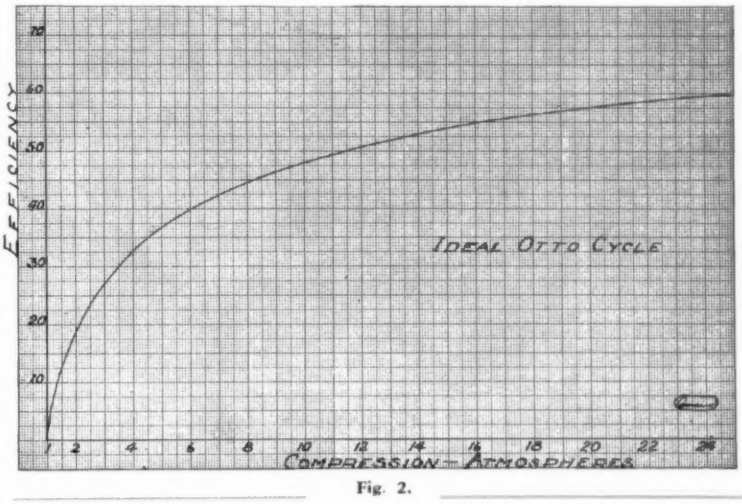

Fig. 2.

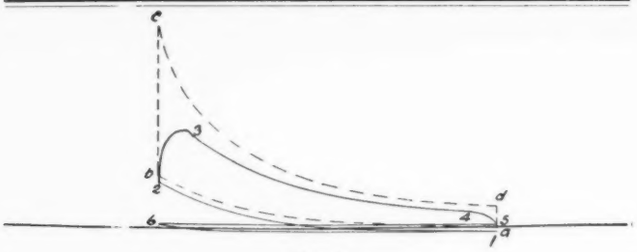

Fig. 3

heat to the gas mixture and the nature of the gases themselves vary from the perfect gas considered in theory. This will cause compression on some exponential value which will vary not only among engines, but between different times on the same engine. At the point 2 the charge is fired and the temperature and pressure rise rapidly. This, however, cannot be as rapid as the instantaneous rise considered on the ideal cycle, as a small amount of time is necessary for the explosion of the charge and during that time the piston will move on the return or work stroke to the neighborhood of point 3. From this point to near the end of the work stroke the gases expand much as from C to D on the ideal card. During this period a great amount of heat is lost to the cylinder walls, since the gases are very hot and the cylinder walls relatively cool. This transfer of heat, together with the nature of the burned gases, causes the expansion line to vary greatly from the adiabatic of the ideal Otto cycle. The two greatest losses in efficiency in a gas engine occur in this portion of the cycle. The first of these, the loss of heat from the gases to the cylinder walls, has already been brought out. The second is the loss of heat in the release and discharge of the hot gases. This begins upon the opening of the exhaust valve at the point 4 and continues through the remainder of the stroke to 5 and through the exhaust stroke to 6. During this period the greatest loss is in the heat contained in the gases discharged, but there is a secondary loss in the power that is necessarily consumed in discharging the burned gases. This loss is small, but is nevertheless a loss to be accounted for and is sometimes greater than would be expected. At the point 6 at the end of the exhaust stroke the exhaust valve closes and the inlet valve opens. The piston makes its return stroke, taking in the new charge of gases. These gases must be sucked into the power cylinder, which again causes a small pumping loss similar to the exhaust stroke. At the end of the intake stroke we are at the starting point and the cycle is repeated. Mechanical losses from defective valves and piston rings cause losses over the entire diagram.

We might at this point discuss the losses that have occurred, with suggestions as to the possibilities for improvement.

1. Variation from ideal adiabatic on compression stroke. This condition in general results in only a small loss and in any event is beyond the control of the operator.

2. Variation from ideal during burning of the charge. The loss might be divided into four parts:

a. Variation caused by loss from improper mixture.

b. Variation caused by loss from improper ignition of the charge.

c. Variation caused by loss of heat from the charge to the cylinder walls.

d. Variation caused by the impossibility of burning the charge instantaneously.

The loss from improper mixture is entirely within the control of the operator on well-designed engines. The proper setting of the mixing valve is best attained by the use of the engine indicator, although approximate settings can be obtained by listening to an opening indicator cock. The more efficient mixture will usually be the one with the quicker rise on the indicator card or the sharpest crack from an indicator cock. The ideal setting of the mixing valve would give a mixture containing neither excess air nor gas. If there is excess gas its entire heat value is lost, together with the heat it takes up in its rise in temperature. With excess air the only loss is from the heat carried off by the air in the exhaust gases. Since this loss is small by comparison to the loss through an excess of gas, it is always best when in doubt to lean toward an excess of air. It is a fortunate condition in gas engines that the mixture that gives the greatest efficiency from burning is also the ideal mixture from the standpoint of explosiveness. It is to be noted that all the above depends upon the complete mixture of the fuel gas and air. If this condition is not obtained the results will vary greatly, but always at a lowered efficiency. It is vitally necessary from the standpoint of thermal efficiency that the mixture be as intimate as is physically possible. The true results of any test can only be obtained by an exhaust gas analysis. Any unburned combustibles found in this analysis are direct losses and the condition should be corrected if at all possible.

The loss from the improper ignition of the charge is entirely within the control of the operator and should be given all the attention necessary. This loss can be caused by either too weak or irregular spark or improper timing. Defective spark plugs, coils, condensers, breakers, batteries, magnetos, condensers and wiring are most usual causes of weak or uncertain spark. The timing of the spark is an individual matter with each engine, because variations in the size, shape, etc., of the combustion chamber will cause variations in the speed of combustion of the mixture. Usually the best practical rule is to advance the spark so as to give as sharp a rise in pressure on the indicator card as possible without interfering with the smooth running of the engine. Once the correct timing of the spark for best operation is found for an engine running at a certain speed on a certain fuel, no change should be necessary.

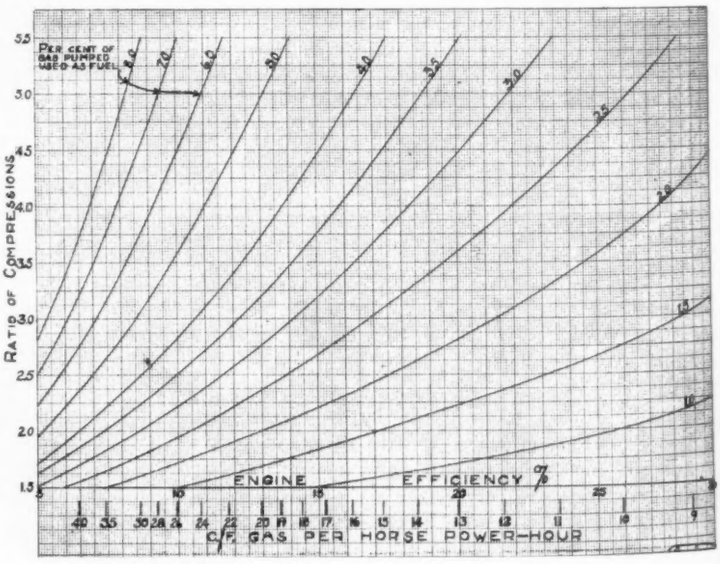

Fig. 4.

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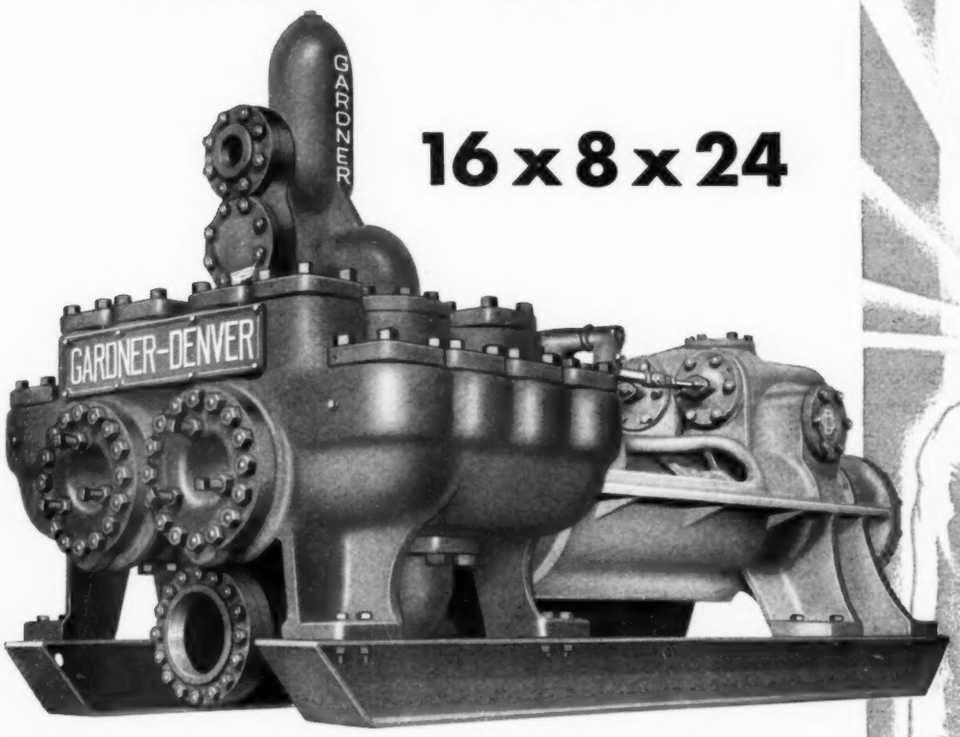

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The spark may be kept at this point indefinitely, and since this is true it is worth considerable effort to obtain the correct setting in the beginning.

The loss of heat from the burning charge to the cylinder walls is not within the control of the operator to any great extent. It is worth remarking, however, that the rate of heat transfer from the gases to the cylinder walls depends somewhat on the temperature of the cylinder wall, which in turn is controlled by the cooling water. For most efficient operation the temperature of the cooling water should be carried as high as it is possible to do so without breaking down the oil film on the cylinder wall. This temperature will vary with different engines and different lubricating oils, so that it is necessary to lean toward too cool a cylinder wall rather than take a chance on the lubricating film being broken down.

The variation from the ideal Otto cycle caused by the impossibility of burning the charge instantaneously is caused by the necessity of a small amount of time for the propagation of the explosive wave through the volume of explosive mixture. This time is small in all engines and the only improvement the operator can make is to see that the mixture and the ignition are correct.

3. Variation from the ideal adiabatic during expansion. This loss is caused by the nature of the gases causing them to expand along some expansion line other than adiabatic and by the heat loss from the exploded mixture to the cylinder walls. The expansion variation is out of the control of the operator and the loss of heat is only slightly controllable through the medium of the cooling water as previously mentioned.

4. The variation from the ideal Otto cycle from the point where the exhaust valve opens to the end of the exhaust stroke is more or less out of the control of the operator, but the following points are worthy of consideration:

a. The exhaust valve should open only early enough to allow the pressure line on the indicator card to fall almost to atmospheric at the end of the stroke.

b. Exhaust passages should be unrestricted and large enough to cause only a small back pressure during the exhaust stroke. The work of pumping out the exhaust gases is a dead loss and should be kept as low as possible.

5. The suction stroke is also a necessary pumping stroke. The loss, or rather use, of power for sucking in the mixture is entirely beyond the control of the operator. Other sources of loss during the suction stroke are caused by the dead gas that is left in the cylinder at the end of the stroke and the heating of the incoming charge by contact with the hot cylinder walls and passages.

The end of the suction stroke brings us back to the beginning, with the cylinder filled with an explosive charge.

The value of the over-all thermal efficiency of a gas engine driving a compressor can usually best be found by converting all work values to British thermal units. To obtain the value in B. t. u. of the fuel gas consumed it is necessary to know the B. t. u. per cubic foot of the fuel gas and the volume of gas used as fuel for a given time, usually an hour. The product of these two is the energy in B. t. u. available in the fuel consumed.

To find the amount of work done by the compressor it is usually best to use the engine indicator. By this the compressor horsepower is found. Then the heat value in B. t. u. for one hour at this rate of power consumption is found by:

$$\text{B. t. u.} = \text{Comp. I. H. P.} \times 2547$$

The over-all thermal efficiency of the engine is the energy of work done divided by the energy of the fuel consumed.

Sometimes it is desired to find the mechanical efficiency of an engine—that is, the ratio of power usefully employed to that developed. To do this it is necessary to know the indicated horsepower of the engine and compressor. Then the mechanical efficiency is given by:

$$\text{Mechanical Efficiency} = \frac{\text{Comp. I. H. P.}}{\text{Eng. I. H. P.}}$$

In order to give a quick reference on over-all thermal efficiencies in engines used in compressing natural gas a chart has been drawn as shown in Fig. 4. With so many variables entering into the calculation it was necessary to give some of them fixed values in order that the chart should not be too complicated. The following have been used:

B. t. u. of fuel gas, per cubic foot	980
Mechanical efficiency	80%
S (in compressor work formula)	1.26

These values will vary, but the above may be taken as averages for the sake of comparison.

In most engine rooms compressing natural gas the fuel gas is metered and the amount of gas pumped is metered or can be fairly accurately calculated. From these two values the percentage of gas pumped and used as fuel is obtained. This percentage, together with the ratio of compressions, are the values necessary for the use of the chart. To use the chart start at ratio of compressions on the left of the sheet and move horizontally to the right to the intersection with the proper "per cent of gas pumped used as fuel" line. Then drop vertically to the base where the over-all thermal efficiency of the engine will be found. Below this base is a second scale laid out to give the cubic feet of gas used per horsepower hour.

The computation of the over-all thermal efficiency of an engine driving an electric generator is much simpler than the case of the compressor. It is only necessary to know the kilowatt hours generated in a given length of time, the cubic feet of fuel gas consumed and the B. t. u. per cubic foot of the fuel gas. Then the efficiency will be given by the formula:

$$\text{Eff.} = \frac{\text{Kilowatt hours} \times 3415}{\text{Cu. ft. fuel} \times \text{B. t. u. per cu. ft.}}$$

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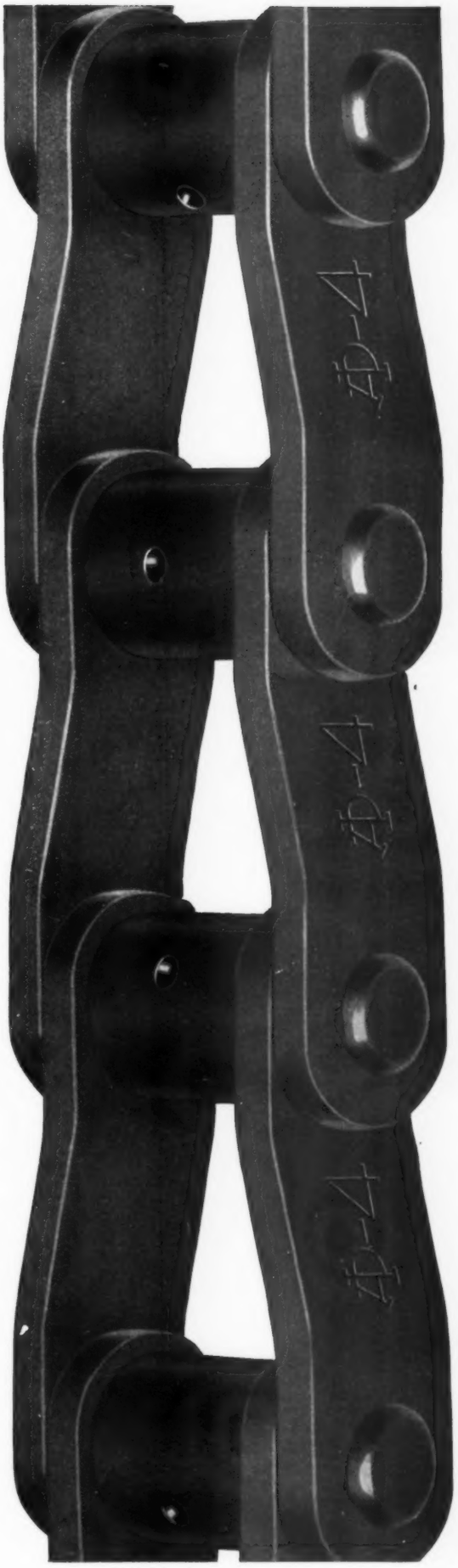

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Benefits *from* Proper Restrictions *of* Flow

By
WARREN L. BAKER

APPLICATION of proper restrictions of flow, accomplished through the regulation of back pressure by means of flow beans, while flowing its Oklahoma City wells between periods of taking potentials, is believed to have been materially beneficial to the Phillips Petroleum Company, and as a result of this practice the future may possibly yield larger returns. Recent compilation of data from exhaustive tests has shown some very constructive and interesting results, among which are (1) conservation of gas energy, (2) increase in gravity of the oil, (3) less gas blown into the air and (4) a reduction in flow velocity, which is an important element at Oklahoma City; additional results which may be anticipated in the future, include a greater ultimate oil recovery and a longer well flowing life.

Field experience has shown the industry that each area has a definite and limited amount of natural expulsion energy associated with the oil in its normal state, and that, evidently, the reaching of an exhaustive producing stage in the life of an oil well is caused more by the exhaustion of the natural lifting forces—in most cases primarily natural gas—rather than by the actual depletion of the oil supp'y in the sand. Therefore, the ultimate yield, or proportion of the oil recovered, depends largely upon how effectively this energy is utilized to expel the oil from the sand.

As gas is the prime "motive force" for the extraction of petroleum crude from the sub-surface reservoir, every foot of gas produced wastefully may be considered to represent a quantity of oil that will not be brought to the surface, and since gas is largely a controllable factor, the efficiency of expulsion may be determined by the amount of gas used in lifting a barrel of oil. Data secured by engineers of the Phillips Petroleum Company shows conclusively that the efficient utilization of gas is of paramount importance in the conservation and economical production of high pressure, large volume, oil wells.

Tests of the Phillips company have been conducted with the primary principle of determining the most efficient gas-oil ratio, since the wells are heavily prorated and are able to make their allowable outlet when the gas factor is reduced to a point that it causes a decrease in the hourly oil recovery. In a number of cases the gas-oil ratio has been cut considerably more than one-half, and in practically all instances at least one-half of the open flow gas-oil ratio. Company figures show that by lowering the gas required to lift a barrel of oil the company has saved 1,001,568,000 cubic feet of gas and that this gas energy so saved will lift 916,890 barrels of oil. This saving for the month of November, 1931, amounted to about 340,000,000 cubic feet of gas, or equivalent to a volume of oil in the reservoir of 412,857 barrels when based on reservoir pressure of 2,200 pounds. Converting this gas back into energy capable of lifting oil to the surface, and using for calculations the average gas-oil ratio of these 51 wells, which was 1,800 cubic feet per barrel, it may be figured that the energy to lift about 190,000 barrels of oil was saved during this month alone.

It is generally considered that the efficiency of the recovery of oil under various natural conditions is greater in a deeper sand because pressures are usually greater; however, the cost of producing small outputs by pumping deep wells partly compensates for the greater energy stored in deeper sands. If the rock pressure is high, each cubic foot of gas contains more energy than if the pressure is low; on the other hand if the well is deep, more energy, and consequently more gas per barrel of oil, is required to lift the oil to the surface. Since the Oklahoma City field is the deepest competitively developed area in the Mid-Continent, these tests on gas-oil ratios are of paramount interest to the oil fraternity.

The first flow bean was installed on the company's Day No. 1, one year ago (February, 1931) and during that month seven other wells were so equipped. The company now has 51 wells flowing through various size chokes. Tests on these 51 wells have shown that the application of proper back pressure on Wilcox sand area wells will materially reduce the gas-oil ratio, as well as result in obtaining higher gravities.

The table accompanying this article shows the data compiled by the company in the Oklahoma City field on 51 wells. The saving on both gravity and gas energy by proper choking is very gratifying and it is believed that the saving in gravity alone far surpasses the cost of the equipment necessary to attain these results. The value of the gas energy saved is less evident but none the less real.

The size of choke and amount of back pressure giving the best results varies considerably on each well. On some wells a one-half-inch choke will give the best ratio and gravity, whereas on other wells the most desirable opening will be as much as four inches, with the majority of wells showing a better gas-oil ratio with a one-inch flow opening. The amount of back pressure applied to these wells by the various size choke openings varies from 100 pounds to 1,400 pounds, with the largest number of the wells producing under 800 to 900 pounds back pressure.

Because of the difference in individual wells it is impossible to designate any particular size opening as the most desirable for the entire field. In some parts of the field individual wells change to a marked extent and consequently need close attention to determine the proper size opening, and for this reason it is necessary to have an adjustable choke of some description in order to realize the maximum saving in gas and to obtain the highest gravity oil, as this way the well is equipped so that any desired opening can be realized. Each well is then experimented with to arrive at the best size opening to produce the lowest gas-oil ratio and the highest gravity. Charts, as shown in figure 1, are then prepared to show these desired openings.

Phillips engineers have found that the gravity of Oklahoma City wells almost invariably increases as the gas-oil ratio decreases and that by seeking the lowest possible ratio they have been repaid by a higher gravity of oil. It may be seen by the chart, figure 1, that the gravity follows the gas-oil ratio and that usually wherever the best ratio is found the highest gravity of oil is also obtained. In some cases, however, the gravity continues to become higher the

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3. **INCREASES PRODUCTION.** Downward stroke, as well as upward stroke, lifts the oil. Rod tension on downward stroke acts as shock absorber, avoiding quick load stress at reversal of stroke. Length of travel of plunger in barrel is increased due to the decrease of fluid weight on rods, thus with the same stroke per minute more oil is produced.

4. **INCREASES LIFE OF TUBING.** Booster Pump provides tubing anchorage near center of string, reducing weaving motion and resultant wear. Constant rod tension also saves wear.

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Fig. 1

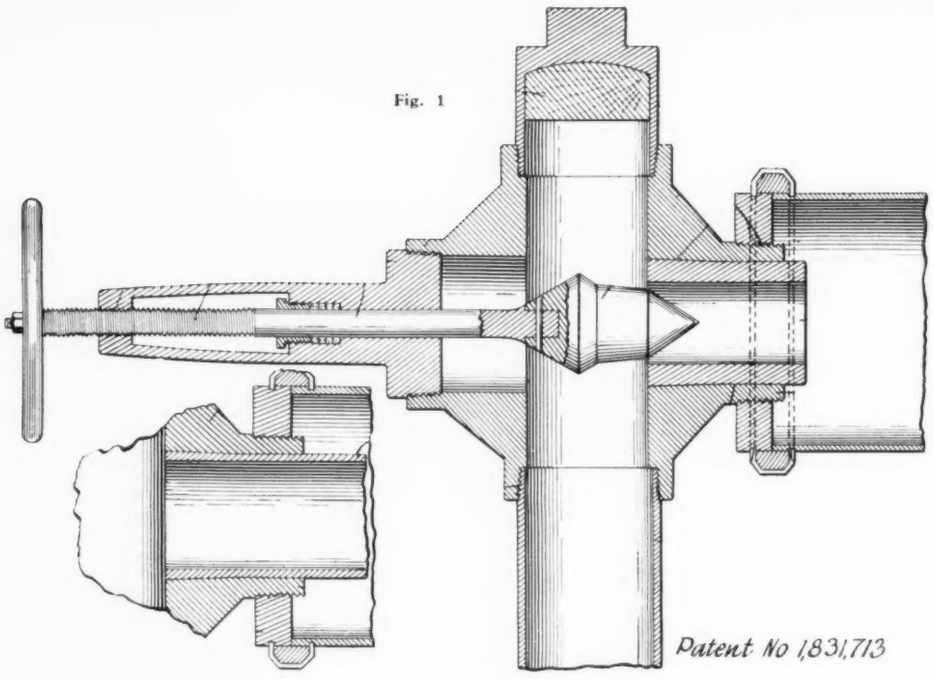


Fig. 2

Figure 1 shows drawing of choke with needle in position for restricting flow. Figure 2 is a diagram showing combination flow head and choke as used for open flow.

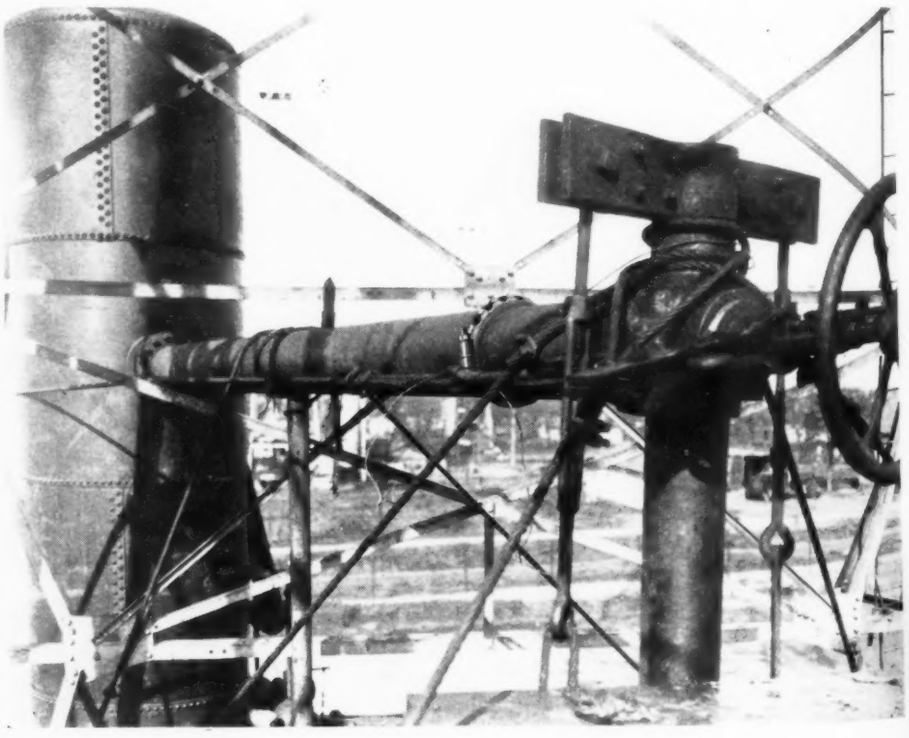
more the well is choked, whereas the gas-oil ratio will reach a minimum and then increase as the flow is further restricted.

In practically all cases the gravity was raised one full degree and on many of the wells it increased two degrees. Company figures show the value of the oil produced on wells that were choked has been increased by $38,956.00, because of the higher gravity of the oil. On the company's Ashcan No. 1 well, the total saving on the gravity due to proper choking has been $5,902.00 over a period of 234 days, or an average of $732.00 per month.

Another advantage of a small rate of gas flow between potential periods is the blowing of less gas into the air. It is frequently the case at Oklahoma City that if many wells are being flowed open at the same time, the gasoline plants are overloaded, whereas if all wells were produced at a slower rate, the load on the gasoline plants would be evened up and much less gas would be blown into the air. This represents a tremendous saving, but it is hard to secure actual figures as to the amount which might be blown into the air over a period of time, as the quantity varies to a very large degree.

The flowing of Oklahoma City wells through chokes has also been a vital factor in retarding sand cutting, since the application of back pressure reduces the velocity of flow. Another important principle in the use of chokes for curtailment of flow is that the controlling of high pressure, sand yielding, producing wells in the field is largely a practice of making them cut out at the place the operator desires, rather than where the well would naturally cut itself out. Since the chokes may be easily and quickly replaced they are considered an ideal place to have sand cutting, and they afford a large protection to the master gates by their application of back pressure to the flow.

Since bringing in the first well in the Oklahoma City field, December 4, 1928, there has been numerous changes in the completion and production practices in the field. The combination of conditions in the field makes the bringing in of one of these wells a very hazardous undertaking. A



Combination Flow-Head and Choke hook-up on Phillips Petroleum Company's No. 1, McBeth at Oklahoma City. Note how hook-up is anchored down with tie rods and wire lines.

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Report of Phillips Petroleum Company Wells in Oklahoma

Well	Size Nov. Pot'l	Choke Best Opening	Date Flow Bean Installed	Back Press Nov. Pot'l	Back Press Best Opening	Bbls. Hrly. Nov. Pot'l	Bbls. Hrly. Best Opening	M. Cu. Ft. Gas Daily Rate Nov. Pot'l	M. Cu. Ft. Gas Daily Rate Best Opening
Ashcan No. 1	6"	1"	4-8-31	100	750	2853	493	38,784	7,080
Ball No. 1	6"	1"	7-1-31	60	1600	491	150	74,584	23,200
Black No. 1	6.3"	1½"	4-17-31	60	700	1820	549	45,000	11,699
Blazer No. 1	6"	1"	4-22-31	60	800	1650	395	24,336	6,400
Boultinghouse No. 1	6"	1"	5-10-31	90	700	1714	366	35,908	7,572
Burt No. 1	6.3"	½"	4-12-31	25	675	892	70	18,600	1,092
Carey No. 1	3" tub & 7" cag.	7/16"	5-5-31	75	100	79	47	1,860	931
Ciger No. 1	1-3½" & 1-4"	1¼"	2-17-31	500	1100	1895	580	144,000	20,700
Clayton No. 1	6.3"	1"	4-13-31	30	1150	970	240	47,200	10,497
Clift No. 1	2-4"	1"	11-6-31	250	900	2538	528	87,620	15,744
Crean No. 1	2-3"	¾"	6-27-31	525	1200	1720	226	119,290	18,554
Damewood No. 1	6.3"	1"	5-24-31	70	725	2374	398	42,810	6,313
Davis No. 1	6.3"	1¼"	5-13-31	65	725	2248	625	40,704	10,368
Day No. 1	5½"	1"	2-7-31	350	1200	1884	380	128,673	26,967
Degn No. 1	2-4"	....	.....	.....	.....	.....	.....	.....	.....
Dora No. 1	6"	1¼"	10-30-31	125	550	1265	424	24,220	6,074
Egermeier No. 1	6"	1½"	10-27-31	100	1200	1254	475	102,500	37,620
Forester No. 1	6.3"	1¼"	7-2-31	175	900	1774	450	49,776	12,646
Hankins No. 1	6.3"	¾"	4-27-31	60	900	180	78	37,600	10,360
Hare No. 1	5¾"	1"	11-2-31	200	800	2343	432	48,264	9,216
Harrell No. 1	2½" US Tub	Tubbed	9-17-31	25	.....	60	.....	1,422	.....
Hatcher No. 1	6.3"	....	None	10	.....	112	.....	1,500	.....
Henderson No. 1	6.3"	1¼"	10-30-31	160	750	1381	476	27,100	13,000
Herchek No. 1	6"	1¼"	4-18-31	60	750	1612	553	34,000	10,335
Higgins No. 1	6.3"	1"	4-8-31	70	1100	1559	285	35,000	6,066
Highland No. 1	6.3"	1"	4-15-31	200	1400	931	245	92,900	27,700
Highland No. 2	6"	1"	11-12-31	180	900	1307	414	32,749	12,800
Johnson No. 1	6.3"	¾"	7-6-31	100	1100	958	181	36,300	7,900
Jones No. 1	4"	1"	2-21-31	40	250	312	146	7,296	2,700
King No. 1	6.3"	1"	2-15-31	60	600	1543	378	34,500	6,576
Kleinegger No. 1	2-3"	1¼"	5-25-31	800	1100	1796	860	203,200	16,670
Leverich No. 1	6"	1"	11-19-31	30	575	1065	242	26,100	4,900
Lybrand No. 1	6.3"	1"	4-20-31	60	825	1827	267	84,600	7,600
McAusland No. 1	6.3"	¾"	4-7-31	70	750	1642	265	33,678	4,660
McBeth No. 1	2-3"	1"	10-16-31	650	600	3023	431	150,000	16,300
Mosey No. 1	1-4" & 1-3"	1¼"	4-16-31	300	1300	1885	500	113,205	28,000
Mosey No. 2	2-3"	....	12-14-31	650	.....	3664	.....	101,695	.....
Nunn No. 1	7"	1½"	4-22-31	125	750	2505	598	60,000	11,700
Othenin No. 1	6"	1¼"	6-22-31	125	700	2378	578	41,088	9,600
Perry No. 1	6.3"	1"	10-31-31	165	600	865	292	24,102	6,072
Qualls No. 1	6"	....	11-19-31	45	.....	561	.....	12,800	.....
Rallen No. 1	2-3½"	1"	2-17-31	320	1200	623	183	104,700	26,832
Reserve No. 1	5¾"	1"	11-6-31	50	700	2378	487	42,792	9,600
Robb No. 1	6.3"	¾"	6-15-31	50	500	368	154	7,176	3,456
Roden No. 1	5"	1"	2-2-31	275	900	2203	374	63,144	10,752
Roose No. 1	Adj. 3½" to 5¼"	1"	5-12-31	25	800	244	102	14,800	3,537
Sam No. 1	4"	1"	10-30-31	525	900	1861	530	81,555	13,330
Shillings No. 1	6.3"	1"	5-29-31	70	500	1340	243	24,840	4,344
Temple No. 1	6.3"	1"	5-17-31	175	1000	1635	269	47,500	10,128
Unruh No. 1	1-3¾"—1-4"	1-1¾"	2-20-31	250	1000	1866	856	176,200	32,112
Velt No. 1	5¼"	¾"	5-14-31	25	250	423	70	8,045	89
Walnut No. 1	6"	1"	3-12-31	200	800	2339	409	51,456	8,182
Winstead No. 1	6.3"	1"	5-19-31	50	550	647	204	24,400	3,198

and no trouble was had. It was necessary to take another four-hour potential on November 19, 1931, and for this purpose two four-inch chokes were used. Upon finding the gas had suddenly increased to approximately 200,000,000 cubic feet, the well was closed and three-inch chokes installed, which created a back pressure of 650 pounds, yet

City Field Showing Results of Proper Restrictions of Flow

Gas/Oil Ratio Nov. Pot'l	Best Opening	Per Cent Inc. & Dec. From Last Pot'l	Gravity Oil Pot'l	Best Opening	Bbls. Oil & Income of Proper Choking Bbls. Raised 1 Degree	Bbls. Raised 2 or More Degrees	Total Gain By Raising Grav. With Chokes	Produced to Dec. 1st Bbls. Oil	M Cu. Ft. Total Gas Saved By Lowering G/O Ratios With Chokes	This Gas Energy Would Lift in Bbls. Oil
665	648	—8.66	38.1	39.6	136,000	86,800	$ 5,902.00	259,656	3,023	4,946
6407	6408	—8.94	40.0	42.5	.....	.....	.....	63,848	.....	.....
1030	817	—17.68	39.0	39.4	.....	.....	.....	194,348	32,887	39,520
614	665	—20.16	38.8	39.2	90,400	.....	1,808.00	176,791	.....	.....
874	862	—17.52	38.7	39.2	92,800	.....	1,856.00	145,347	1,308	1,517
892	650	.....	38.4	39.5	50,800	.....	1,016.00	81,464	16,559	25,468
971	817	—1.6	39.2	39.3	.....	.....	.....	16,362	1,232	1,508
3165	1481	—24.94	39.7	39.6	7,800	.....	156.00	335,590	296,000	199,864
2026	1806	—24.63	38.8	40.3	107,900	7,800	2,470.00	137,352	19,580	10,842
1437	1495	.....	39.4	39.8	5,200	.....	104.00	47,854	.....	.....
2690	3405	+60.00	38.7	39.8	24,700	11,700	1,064.00	68,275	.....	.....
751	661	—2.72	39.6	39.7	.....	.....	.....	150,655	9,773	14,793
754	759	—7.70	38.9	39.5	42,900	1,300	910.00	169,254	.....	.....
2846	2957	—24.58	39.5	39.8	139,000	.....	2,704.00	330,947	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	9,966	.....	.....
797	995	.....	38.8	39.8	30,300	.....	606.00	33,475	.....	.....
3528	3300	.....	39.4	40.3	8,300	.....	166.00	20,914	3,876	1,147
1171	936	+8.8	38.9	39.8	52,800	8,800	1,408.00	84,882	12,607	13,469
8666	5462	—8.84	38.4	40.2	2,800	1,600	88.00	19,176	33,565	6,154
856	887	.....	39.2	39.6	.....	.....	.....	54,049	.....	.....
979	.....	—25.72	38.1	.....	.....	.....	.....	18,901	.....	.....
555	.....	—27.89	38.4	.....	.....	.....	.....	31,384	.....	.....
818	1141	.....	39.6	39.9	.....	9,100	182.00	43,436	.....	.....
878	777	—20.96	38.9	39.3	113,000	.....	2,260.00	169,768	13,426	17,279
928	884	—19.47	39.4	40.0	9,200	.....	184.00	193,182	6,512	7,715
4271	4699	—30.89	39.9	39.9	.....	.....	.....	146,654	.....	.....
1044	1336	.....	39.6	39.8	.....	.....	.....	29,236	.....	.....
1577	1824	—6.75	39.4	40.1	16,000	.....	320.00	56,463	.....	.....
974	787	+143.35	38.9	39.9	3,600	4,800	264.00	29,749	2,047	2,106
931	729	—20.84	38.7	39.3	128,000	.....	2,560.00	221,264	21,171	29,041
4714	1890	—1.1	38.8	39.5	56,800	12,800	1,648.00	93,909	61,815	33,520
1021	850	.....	38.5	39.2	9,600	.....	192 00	22,134	1,435	1,736
994	871	—16.29	39.3	40.0	28,800	.....	576.00	333,548	25,036	28,743
855	760	—24.8	39.3	40.0	6,500	.....	130.00	238,197	17,373	22,860
2067	1576	—19.88	39.6	40.0	12,400	.....	248.00	88,425	15,429	9,789
2501	2319	+44.37	39.4	39.8	44,200	.....	884.00	101,930	10,360	4,460
1156	.....	.....	38.8	.....	.....	.....	.....	31,785	.....	.....
994	820	—14.48	39.0	39.4	9,100	.....	182.00	237,695	33,930	41,373
719	696	—5.31	39.1	39.8	12,000	.....	240.00	126,008	19,556	2,808
1182	666	.....	39.0	39.2	.....	.....	.....	28,255	7,165	11,664
949	.....	.....	38.1	.....	.....	.....	.....	9,508	.....	.....
6999	6092	—37.4	37.8	39.8	12,800	44,000	1,520.00	108,920	83,444	13,697
749	812	.....	39.1	39.8	.....	.....	.....	49,235	.....	.....
811	932	—22.2	39.9	40.1	2,400	.....	48.00	31,477	.....	.....
1145	1191	—9.05	39.1	39.8	40,400	.....	808.00	335,150	.....	.....
2524	1438	—36.27	37.5	39.3	22,800	8,200	780.00	49,268	24,564	10,782
1825	1040	.....	38.8	39.7	42,400	8,000	1,008.00	55,794	23,550	30,000
772	734	—8.72	38.8	39.4	39,000	2,600	884.00	89,941	2,128	2,899
1209	1578	—15.17	38.8	39.3	92,400	.....	1,848.00	110,476	.....	.....
2594	1541	—22.2	39.6	39.8	10,400	.....	208.00	274,670	94,770	61,499
791	330	—9.79	38.1	39.3	5,600	.....	112.00	71,302	10,603	32,130
1127	761	—11.84	39.3	39.6	76,700	.....	1,534.00	308,963	73,566	96,670
1571	635	—18.34	39.6	40.0	3,900	.....	78.00	56,346	23,400	36,862
							$38,956.00	6,194,178	1,001,568	916,890

the rate of flow was 72,115 barrels of oil and 120,000,000 cubic feet of gas. It is interesting that although the well was completed in March it was not until last July that a full four-hour potential test was secured, because of cutting action of the sand.

The Westgate Oil Company's Carey No. 3 made an

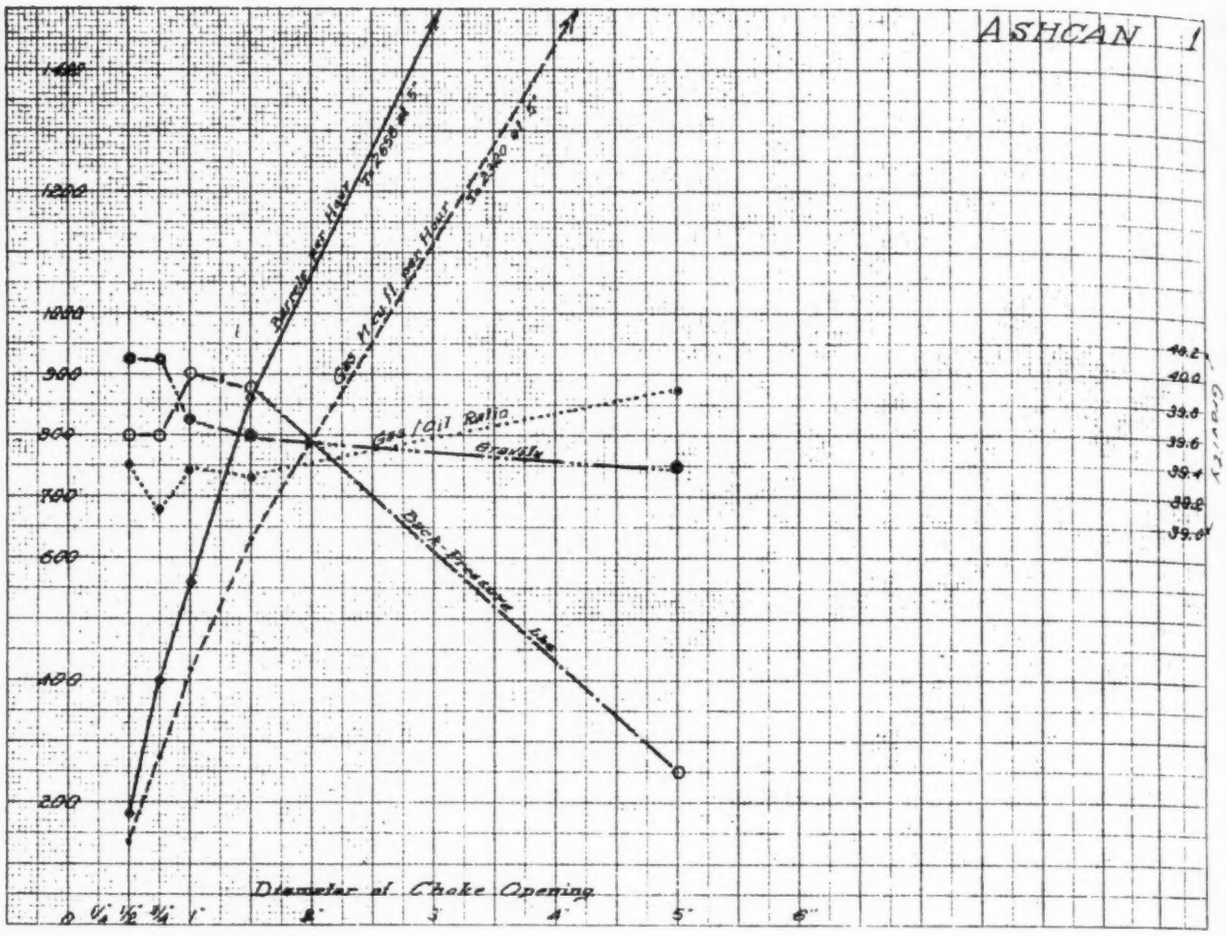

Figure 1. Chart shows graphically the effect of various size openings and back pressure on rate of production, gas-oil ratio, and gravity of oil on a typical Wilcox sand well at Oklahoma City.

great deal of experimenting on the part of many of the companies has been carried on to cope with the high rock pressures, large gas volumes and excessive amount of sand produced with the oil. The result has been an evolution of methods and equipment to arrive at the recognized practices now in use in the field.

The larger wells are literally in the backyard of Oklahoma City, and when we consider these wells have produced as much as 10 to 30 per cent sand, which means from 200 to 800 barrels of sand per hour and as much as 50 to 100 million cubic feet of gas, besides their oil production, which is sometimes as high as 4,200 barrels per hour, and that the velocity of flow rate of travel is from 300 to 400 miles, or more, per hour, one can readily see why these wells are treated with a great deal of respect, and why the retarding of the flow velocity is a material help in controlling the wells.

In order to best visualize the magnitude of these enormous wells and the difficulties experienced in their production, a review of the history of two wells, which are the largest in the field and among the largest in the world, will be helpful. These wells were both completed with a 9⅝-inch casing flow string which was cemented on top of the Wilcox sand.

One of these wells, Phillips Petroleum Company's McBeth No. 1, Section 10-11-3w, was completed on March 28, 1931, through one four-inch choke, six inches long, and one 6x25-foot separator and two 5x15-foot separators. The daily rate of flow was 71,064 barrels of oil and 45,000,000 cubic feet of gas, and an estimated 24 per cent sand content. The actual gauge of this sand was 1,004 barrels during one hour and 25 minutes, when it cut out the choke and flow line.

On May 25, 1931, when the well was again opened, an additional 6x25-foot separator had been installed, and two 3¼-inch chokes were used, but again connections were cut. The rate of flow this time was 100,992 barrels of oil and 67,200,000 cubic feet of gas, with 15 to 20 per cent sand. A later open flow of the well was at the rate of

101,616 barrels of oil and an estimated 67,000,000 cubic feet of gas.

On October 16th, an adjustable flow bean was installed in the 9⅝-inch flow head and it was opened to one-inch. Soon after opening the well, sand closed the flow bean opening and it was necessary to open the bean to allow the sand to pass through. This occurred several times, but as soon as the flow bean was opened the sand passed through and oil and gas came again. After 24 hours of continuous flowing the well was making very little sand initial flow at the rate of 84,528 barrels of oil and 62,000,000 cubic feet of gas, with a sand content estimated at 6 per cent. The well was immediately shut in for replacements of cut connections and not opened until three weeks later, August 22, 1931. This time it was opened through a 4½-inch choke with 600 pounds back pressure for three hours, making 10,255 barrels of oil, which is equivalent to 82,040 barrels in 24 hours, with 40,000,000 cubic feet of gas. Against this back pressure the well made very little or no sand. The first full four-hour potential flow of the well was taken on October 29, 1931, and the well flowed 16,090 barrels during that time, or equal to 96,540 barrels in 24 hours. This large flow was made through a 5-1/16-inch choke with 400 pounds back pressure. The well was equipped with an adjustable flow bean after the potential and later flowed from 500 to 1,000 barrels per hour through openings varying from one-quarter-inch to three-eighths of an inch in diameter.

As the monthly allowable production of each well is based on a four-hour continuous flow, it is imperative that the well does not cut out the connections during this time. In order to protect the vital controlling parts of the well, such as master gates or nipples between master gates, some operators are bringing their wells in through chokes of various sizes in order to create a back pressure through the master gates, which slows down the velocities to such an extent that cutting does not occur. The city requires three master gates to each well, and these are often none too many.

Phillips Petroleum Company and several others have standardized on the combination flow head and adjustable flow bean, which confines the flow to the inside diameter of the casing until the turn is made to the separators. The enlarged flow line from this turn to the separators is then utilized for an expansion chamber to reduce the velocities before entering the separators. This type of hook-up may be easily and quickly converted to a restricted flow, or vice versa. When changing to a restricted flow the blank bull plug is removed from the nipple and the stuffing box assembly with the nipple valve is screwed into the cross tee. After determining the most desirable size opening for the well, the stuffing box assembly can be moved to another well, and the removable choke can be replaced with a choke with a size opening found most desirable for restricting the flow and controlling the gas-oil ratio during periods between taking potentials.

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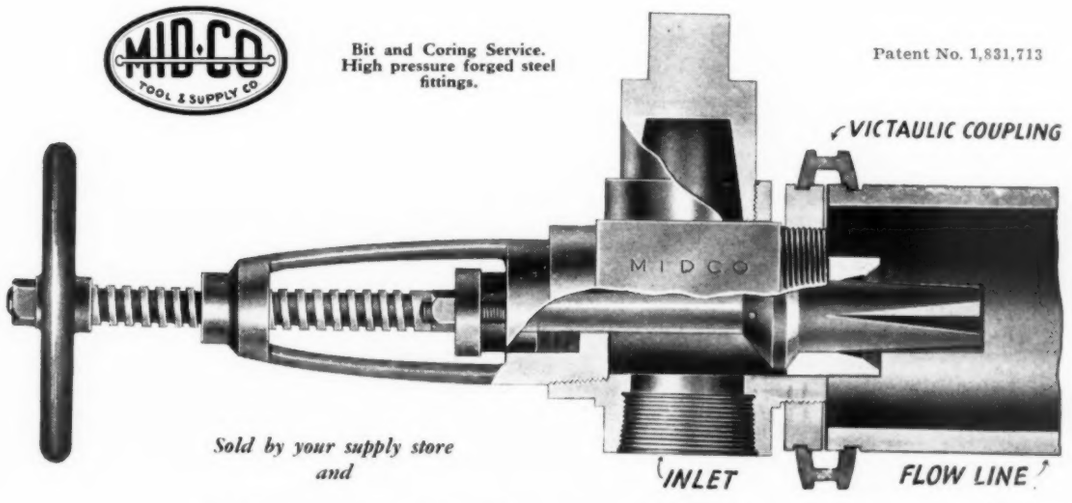

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Answering

WHO SELLS ETHYL?

A SURVEY of thousands of individual car owners has just been completed. They were questioned—sitting in their cars—on the streets of 43 cities, towns and villages from Portland, Maine, to Portland, Oregon.

The result:

23% of the low-priced (below $1000) cars use Ethyl Gasoline *regularly*.

27% of the medium-priced ($1001-$2200) cars use Ethyl Gasoline *regularly*.

42% of the high-priced (over $2201) cars use Ethyl Gasoline *regularly*.

39% of all car owners interviewed buy Ethyl Gasoline either regularly, part of the year, or occasionally.

In other words, men and women owning cars of *every* make and price class are among the several million satisfied users who make

Here are the names of the oil refining companies selling Ethyl Gasoline. Nearly

Aetna Oil Service, Inc. AETNA ETHYL
Allegheny-Arrow Oil Co. ARROW ETHYL
American Oil Company AMERICAN ETHYL
Anglo-American Oil Company, Limited PRATTS ETHYL PETROL
Ashland Refining Company, Inc. RED PEPPER ETHYL
Associated Oil Company ASSOCIATED ETHYL
Atlantic Refining Company ATLANTIC ETHYL
Barnsdall Corporation SUPER-GAS ETHYL
British American Oil Company, Limited BRITISH-AMERICAN ETHYL
Canfield Oil Company CANFIELD ETHYL
Champlin Refining Company CHAMPLIN ETHYL
Colonial Beacon Oil Company, Inc. ESSO (with Ethyl)
Col-Tex Refining Company COL-TEX ETHYL
Continental Oil Company CONOCO ETHYL
Continental Refining Company CORECO ETHYL
Crystal Oil Refining Corporation CRYSTAL ETHYL
Deep Rock Oil Corporation KANT-NOCK ETHYL
Eason Oil Company EASON ETHYL
Elk Refining Company ELK ETHYL
Fleet-Wing Oil Corporation FLEET-WING ETHYL
Freedom Oil Works Company FREEDOM ETHYL
Garber Refinery, Inc. OMAR ETHYL
General Petroleum Corporation of California GENERAL ETHYL
Glasgow Oil and Refining Company, Inc. GLYCO ETHYL
Globe Oil & Refining Co. GLOBE ETHYL
Gulf Refining Company *NO-NOX ETHYL
Hickok Oil Corporation HI-SPEED ETHYL
Home Oil Distributors, Limited HOME ETHYL
Humble Oil & Refining Company ESSO (with Ethyl)
Imperial Oil, Limited IMPERIAL ETHYL
Independent Oil and Gas Company INDEPENDENT ETHYL
Indian Refining Company, Inc. TEXACO ETHYL
Johnson Oil Refining Company JOHNSON ETHYL
Kanotex Refining Company KANOTEX ETHYL
Kendall Refining Company KENDALL ETHYL
Latonia Refining Corporation SOHIO ETHYL and FLEET-WING ETHYL
Lincoln Oil Refining Company LINCO ETHYL
Lion Oil Refining Company LION ETHYL
Louisiana Oil Refining Corporation LORECO ETHYL
Lubrite Refining Corporation, MOBILGAS ETHYL
Magnolia Petroleum Company MAGNOLIA ETHYL
McColl-Frontenac Oil Co., Ltd. CYCLO ETHYL
Mexican Petroleum Corporation, PAN-AM ETHYL
Mid-Continent Petroleum Corporation NEVR-NOX ETHYL
Midwest Refining Company MIDWEST ETHYL
A. D. Miller Sons' Company MILLER'S ETHYL
National Refining Company WHITE ROSE ETHYL
Ohio Oil Company MARATHON ETHYL
Oil Creek Refining Company OIL CREEK ETHYL
Pan American Petroleum Corporation PAN-AM ETHYL
Pasotex Petroleum Company RED CROWN ETHYL

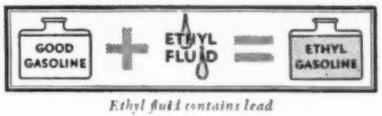
your Questions:

WHO BUYS ETHYL?

Ethyl Gasoline the largest selling brand of motor fuel in the United States and Canada.

Many of these car owners know practically nothing about compression ratios and the anti-knock qualities of gasoline. But they do know that Ethyl makes ANY car run better. Many who own cars with relatively low compression engines buy Ethyl Gasoline because they are willing to pay a premium for the better performance it gives their cars.

The trust the American public places in Ethyl Gasoline is justified by its quality on every count. Each oil refiner selling Ethyl uses a base gasoline that will pass tests for purity and volatility in Ethyl laboratories, then adds at least enough Ethyl fluid to bring the anti-knock rating up to the Ethyl standard. After the finished Ethyl Gasoline has been approved and released for distribution, inspectors collect samples from roadside pumps for checking. The quality of Ethyl Gasoline is thus doubly safeguarded. Ethyl Gasoline Corporation, Chrysler Building, New York City.



Ethyl fluid contains lead

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every leading oil refiner in the United States and Canada is included in this roll call.

Pennsylvania Oil Products Refining Co. ELDRED ETHYL
Pennsylvania Refining Company PENN-DRAKE ETHYL
Pennzoil Company PENNZOIL ETHYL
Phillips Petroleum Company PHILLIPS '66' ETHYL
Producers and Refiners Corporation PARCO ETHYL
Pure Oil Company PUROL ETHYL
Refiners, Inc. REFINERS ETHYL
Regal Petroleum Company, Limited REGAL '66' ETHYL
Richfield Oil Company of California RICHFIELD ETHYL
Richfield Oil Corporation of New York RICHFIELD ETHYL
Rio Grande Oil Company, RIO GRANDE ETHYL
Root Refining Company ROOT ETHYL
Shell Company of Canada, Limited SUPER-SHELL ETHYL
Shell Eastern Petroleum Products, Inc. SUPER-SHELL ETHYL
Shell Petroleum Corporation SUPER-SHELL ETHYL
Shreveport-El Dorado Pipe Line Company SPARCO ETHYL
Sinclair Cuba Oil Company, S. A. SINCLAIR H-C GASOLINE with ETHYL
Sinclair Refining Company SINCLAIR H-C GASOLINE with ETHYL
Skelly Oil Company, SKELLY AROMAX ETHYL
Solar Refining Company SOLAR ETHYL
Standard Oil Company of California STANDARD ETHYL
Standard Oil Company of Cuba ESSO (with Ethyl)
Standard Oil Company (Indiana) RED CROWN ETHYL
Standard Oil Company (Kentucky) CROWN ETHYL
Standard Oil Company of Louisiana STANDARD ETHYL and ESSO (with Ethyl)
Standard Oil Company (Nebraska) RED CROWN ETHYL
Standard Oil Company of New Jersey STANDARD ETHYL and ESSO (with Ethyl)
Standard Oil Company of New York SOCONY SPECIAL plus ETHYL
Standard Oil Company (Ohio) SOHIO ETHYL
Standard Oil Company of Pennsylvania STANDARD ETHYL and ESSO (with Ethyl)
Sterling Oil Company STERLING ETHYL
Stoll Oil Refining Co., Inc. STOLL ETHYL
Texas Company TEXACO ETHYL
Texas Pacific Coal and Oil Company T-P ETHYL
Tidal Refining Company TYDOL ETHYL
Tide Water Oil Company TYDOL ETHYL
Tri-State Refining Company TRI-STATE ETHYL
Union Oil Company of California, UNION ETHYL
United Refining Company KEYSTONE ETHYL
Utah Oil Refining Company PEP '88' ETHYL
Vacuum Oil Company, Inc. MOBILGAS ETHYL
Wadhams Oil Corporation WADHAMS ETHYL
Waverly Oil Works Company, WAVERLY ETHYL
White Eagle Oil Corporation WHITE EAGLE ETHYL
White Star Refining Co. WHITE STAR ETHYL
H. F. Wilcox Oil & Gas Company WILCOX ETHYL
Wirt Franklin Petroleum Corporation PALACINE ETHYL
Wolverine-Empire Refining Company, Inc. EMPIRE ETHYL

Road Pitch a Factor in

Proper Placement of Dual-Wheel Truck Tires

THE proper placing of tires on dual-wheel trucks is a vital factor in securing satisfactory tire service, since road pitch is an element worthy of consideration. The general practice in the oil industry has been to put the worn tire on the outside wheel, the idea being that this tire would give the most trouble, and by putting it on the outside less difficulty would be encountered in taking it off the wheel and replacing it. It is true that the outer tire of a dual-wheel drive is the easiest to remove, but this practice, according to Frank Gable, chief engineer of The General Tire & Rubber Company, is a very poor one, and really reduces the amount of mileage that will be secured from the tires.

Few truckers have stopped to consider the important part that the pitch of the road has on dual-wheel tires. Practically all of our roads have a pitch in some degree or other to the outside, and even on our city streets, where the pitch is not so prominent, it is sufficient to play an important part in tire service on dual-wheels. The pitch places the heaviest weight on the inside tire, since it rides on the higher part of the road crest.

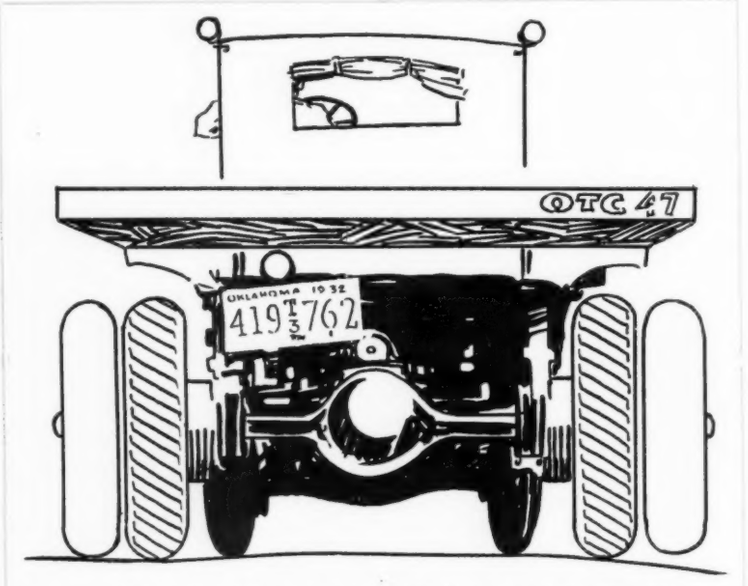


Illustration showing old tire on right wheel. Notice how it is riding "free" due to road pitch.

If the worn tire is placed on the outside wheel, it will practically ride "free," that is, it will not bear its proportional load, as its circumference has been reduced from wear, and the larger circumference of a newer tire, together with its path on the higher portion of the road crest, will keep the older tire from reaching the roadway. This condition will place the entire truckload on the new tire and overburden it, although it is perhaps a much better tire than the older one. Such a condition will materially damage the newer tire, until its service will be unsatisfactory and much more trouble from tires will occur.

If the old tire is placed on the inside and the better one on the outside, their difference in circumference will make up for the dip in the road crest to the outside, and each tire will bear its proportional part of the load, consequently, many more miles will be secured from the tires.

In buying tires for any kind of vehicle, there are two general important factors to be considered, namely, selection of the proper tire and carrying the right air pressure. These two elements apply to all vehicles, but particularly to trucks because of heavy duties imposed upon tires.

In selecting the right tire, the amount of weight to be carried needs to be considered in conjunction with the road speed at which the truck will operate, and it is a good policy to consult a good tire company representative for his opinion. Tires are made in several classes, those for heavy hauling, speed and general duty.

Trucking concerns use the one adaptable for heavy hauling, except in a few cases where speed is more essential. The heavy hauling class of tire will carry a tremendous weight load without breaking, but is not built for speeds of 40 and 50 miles per hour and will soon wear out if driven constantly at these speeds.

The general duty or all-round tire is used on passenger cars and light capacity trucks. The speed type of tire is seldom to be found in use in the oil industry, as it is built to withstand excessively high speeds and that condition alone.

We frequently see a heavily loaded truck on the road that is being driven at 40 and 50 miles per hour, and in most cases the advantage gained in speed of moving the equipment will later be lost by additional tire trouble on the road, which will mean long delays.

The majority of transportation superintendents have some time or other encountered the baffling problem of an increased air pressure in tires where they are driven steadily on a long haul. This is due to the higher temperature of tires under such condition, due to friction contact with the road. Many truck drivers let sufficient air out of the tire to reduce the pressure to normal when they find this condition, but when this is done the tires will show an air pressure below that desired when the truck is stopped for a short period of time. An air pressure below normal is most injurious to tires, especially on heavy trucks, and should be corrected at once. It is better to permit the pressure in the tire to build up 10 to 15 pounds excessive pressure during a long haul than to let the air out. The pressure will go back to normal when the truck is stopped long enough for the tires to cool off.

Truck tires should be checked each morning before starting out on the road and as often during the day as is possible. A rigid daily inspection system should include, as well as a check for minimum air pressure, inspection for breaks in the *tire carcass,* principal cause of which is underinflation, and inspection for cuts and bruises. The inspection for breaks, cuts and bruises permits the removal of the tire and its repair, before a blowout occurs on the road, and will increase tire mileage, since blowouts on the road damage the entire tire as it necessarily means traveling of considerable distance before the unit can be brought to a stop and with a heavy load the distance of travel on a flat tire need not be far before the tire is cut in many places.

New CRANE steel welding materials ...a complete line

Crane Co. offers a complete line of steel welding materials, designed to meet all needs for welding installations in pipe lines and plants. When you make up welded joints for higher pressures and temperatures, you will find in this line the fittings exactly adapted to modern needs.

Included in it are 90° and 45° elbows, tees, return bends; also welding neck flanges and Cranelap welding nipples.

The materials are of open hearth steel tubing or steel plate. Each item has been designed, tested, and proved for service at the pressures for which it is recommended. Satisfaction and dependability are assured by the 77 year Crane reputation.

Sizes 1″ to 18″ of the 45° and 90° elbows are made from seamless tubing; tees of forgings; return bends of seamless tubing in sizes from 1″ to 6″ with various centers up to 18″.

Welding neck flanges are made of forgings, in four classes: Series 15 for 125 pounds, hot oil at 750° F., 280 pounds gas or air at atmospheric temperatures; Series 30 for 300 pounds, hot oil at 750° F., 500 pounds gas or air at atmospheric temperatures; Series 40 for 400 pounds, hot oil at 750° F., 800 pounds gas or air at atmospheric temperatures; Series 60 for 600 pounds, hot oil at 750° F., and 1200 pounds gas or air at atmospheric temperatures.

Cranelap welding nipples in standard and extra strong pipe thickness are supplied for use in combination with forged steel Cranelap flanges. These nipples have a Cranelap on one end and are beveled for welding on the opposite end. All nipples 1½″ to 12″ in diameter are 12″ long. Cranelap forged steel flanges in Series 15, 30, 40, and 60 can be supplied with them. Write for full information.

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO
NEW YORK: 23 W. 44TH STREET
Branches and Sales Offices in One Hundred and Ninety Cities

Combination of No. 574 Cranelap welding nipple and No. 572 Cranelap Flange.

No. 568 Series 15 Welding Neck Flange.

No. 353-E Tee. 1″ to 10″

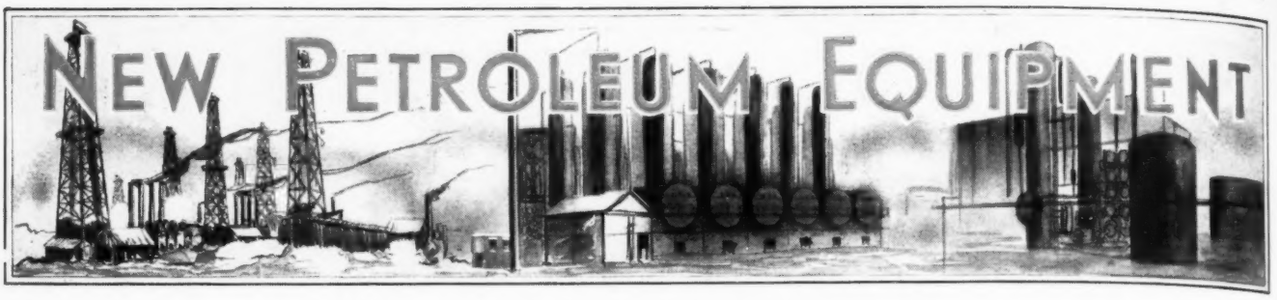
No. 352-E 90° Elbow. In 1″ to 18″ sizes.

No. 355-E Return Bend. In 1″ to 6″ sizes with various centers.

No. 354-E 45° Elbow. In 1″ to 18″ sizes.

CRANE

PIPING MATERIALS TO CONVEY AND CONTROL STEAM, LIQUIDS, OILS, GAS, CHEMICALS



Chapman Tilting Disc Valve

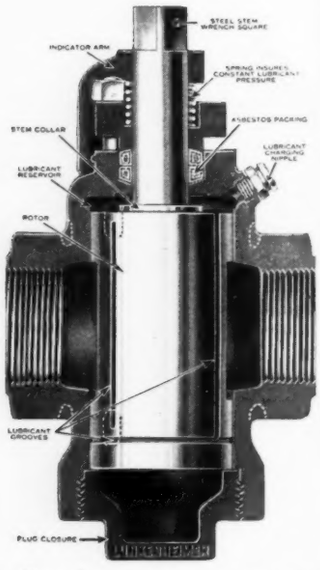
THE Chapman Valve Manufacturing Company of Indian Orchard, Mass., has placed the Chapman Tilting Disc Valve on the market.

This valve consists essentially of the rigid circular disc, pivoted within a cylindrical housing. The seats are of the circular bevel type and the disc drops cleanly into contact with rubbing. This is accomplished by arranging the disc to rotate about fixed pivots, offset from the seat. The pivot is made with a slight clearance so that the disc seat makes complete contact with the seat in the body, when in closed position, and is drop tight. The location of the pivots and the angle and bevel of the seats can be changed to meet numerous applications. Severe wearing of moving parts is reduced since the seats move out of contact without any rubbing or wearing, and as the pivots are bushed with nitrided steel, which will wear indefinitely, the manufacturer states.

The valve has applications wherever check valves and stop valves are used.

Further details of this new Tilting Disc Valve may be secured from the Chapman Valve Manufacturing Company or from the Mid-Continent factory representative, the Taubman Supply Corporation, Tulsa, Okla.

Lunkenheimer Lubricated Rotor Valve



THE Lunkenheimer "Slaset" lubricated rotor valve is simple in design, consisting essentially of a straight-bored body and cylindrical rotor. It provides the advantages of self-lubrication, absolute sealing and easy turning.

In the "Slaset" Valve, lubricant is forced into the reservoir above the closed top of the rotor, the pressure forcing the rotor down as the reservoir fills. The pipe line pressure, aided by an external spring, causes the rotor to act as a booster plunger, which forces the lubricant into pockets in the body and grooves in the rotor. From here it is distributed to form a protecting lubricant film for the bearing surfaces, as well as a complete seal when the valve is closed.

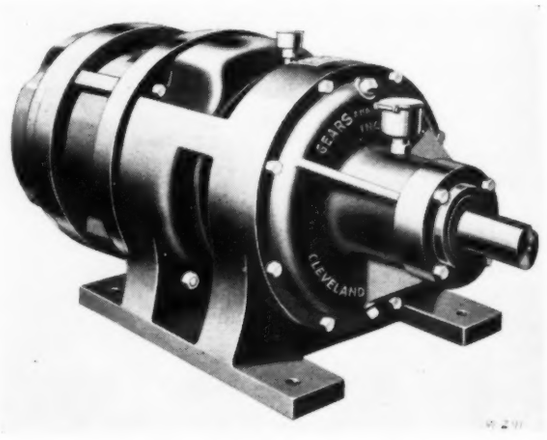
When the valve is operated the sealing groove, which passes the port, does not contact the lubricant reservoir, and there is no material loss of lubricant.

An indicator attached to the stem serves a three-fold purpose. It acts as a positive open and closed stop; plainly shows whether the valve is open or closed, and indicates the relative amount of lubricant in the reservoir.

A unique feature of the "Slaset" Valve is that the stem and rotor are not integral. The stem is made of steel. The flexible stem-rotor connection permits the rotor to seat without binding or "cocking," even though the packing may be compressed unevenly around the stem.

A copy of Folder F-516, describing this valve, may be secured from The Lunkenheimer Co., Cincinnati, Ohio.

Motorized Speed Reducer, Planetary Type



A SPEED reducer of the planetary type built integral with an electric motor, forming a single, neat and compact unit known as a motorized speed reducer, has recently been placed on the market by Gears and Forgings, Inc., Cleveland, Ohio.

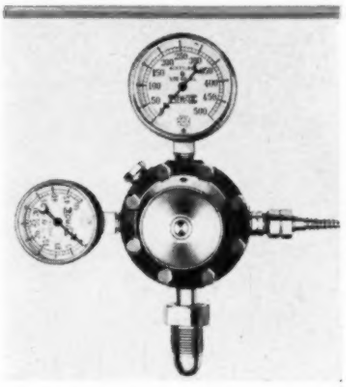
This self-powered and self-contained type of speed reducer is designed particularly for applications where available space for the driving mechanism is limited. Due to the simplicity of G. & F. planetary design, this type of unit secures great reduction and requires only a small space.

The housing of the reduction gears is dust-proof and oil-tight. It is integral with base which extends to center line of motor and also provides rigid support to gearing and output shaft which carries the load. No additional loads are imposed on motor shaft which is supported by two ball bearings.

This motorized speed reducer is built in 34 standard ratios ranging from 4:1 to 240:1, inclusive, and in sizes ranging from one-quarter horsepower to 30 horsepower.

New Purox Regulators

THE Linde Air Products Company, 30 East 42nd Street, New York, N. Y., has recently introduced an entire series of new and improved Purox oxygen and acetylene regulators superseding its former line of Purox Metal Master type of regulators. All Purox welding or cutting outfits now include these new regulators where formerly Metal Master regulators were supplied as part of the regular equipment.



Purox No. 34 acetylene regulator.

The new Purox series comprises six regulators, designated as Nos. 33 and 34 for acetylene; Nos. 13, 14, 23 and 24 for oxygen. All regulators in this series have the same general external appearance. They are of all-metal construction, simple, compact, rugged and workmanlike in appearance and thoroughly reliable in performance. The required volumes of oxygen and acetylene essential for maintaining a neutral flame at the blowpipe tip are delivered to the welding or cutting blowpipe at uniform pressure.

One of the outstanding design features of the new Purox regulators is an accurate self-aligning valve of the nozzle and yoke type, insuring sensitive action and freedom from leakage. Simplicity of construction also eliminates any need of disturbing the diaphragm, bonnet, pressure adjusting screw, or pressure adjusting spring when replacing a worn valve seat. Access to the interior of the regulator is gained by merely removing a plug in the rear of the body. The seats are made of a material not easily marred, scratched or damaged by foreign particles that might find their way into the inside of the regulator.

The diaphragms are made of a special corrosion-resisting alloy, assuring long life. A rupturing disc safety release on the oxygen regulator provides protection to the diaphragm should an abnormal pressure occur. Although seldom if ever necessary, the operation of replacing the diaphragm is quite simple. The cap bolts are merely removed and the diaphragm and yoke lifted out, no special tools being required.

Gauges for the new Purox regulators are heavy and well made in order to withstand the incidental rough usage of field work. The cases are polished brass with beveled plate glass crystals. The working pressure gauges are 2-inch and the cylinder pressure gauges 2½ inches in diameter.

In accordance with the standard color specification for oxy-acetylene equipment, oxygen regulators are painted green, and acetylene regulators red.

Purox regulators are listed as standard by the Underwriters' Laboratories and the Factory Mutuals Laboratories.

Induced Draft Cooling Tower

THE Schubert-Christy Corporation, located at Affton, Mo., recently placed on the market the new Induced Draft Cooling Tower, especially adaptable to oil field service, as it produces low water temperatures so desirable in refinery and gasoline plant operations.

The fans are located at the top of this tower and handle the warm exhaust air only, which prevents formation of ice on the fan blades. By placing the fans above the filling a uniform flow of air throughout the tower is acquired. Fan houses have been eliminated, simplifying foundations and reducing space requirements. The entire structure is bolted together, giving it extreme strength and making it portable.

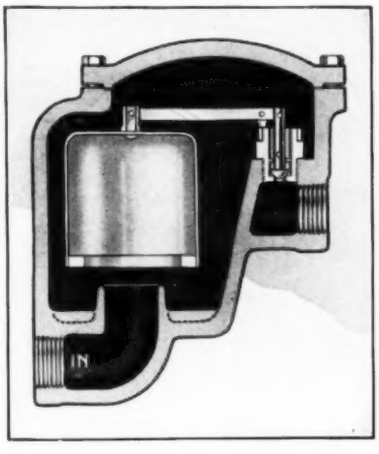
Multi-speed remote control of fans permits the operator to regulate the fan speed to properly handle any weather or load conditions. The large natural draft openings make it possible to shut down the fans entirely during a large portion of the year.

The tower is constructed of fine cypress or redwood, treated with a special wood preservative of high penetrating power. All metal parts are thoroughly rust-proofed or made of non-ferrous composition.

Apex Inverted Bucket Type Steam Trap

THE Apex Regulator Co., division of the Fisher Governor Co., announces bulletin No. 1005X covering the Apex Class ST inverted bucket type of steam trap or condensate drainer. The trap is built in ⅜-inch, ½-inch, ¾-inch and 1-inch pipe sizes, suitable for all steam pressures up to a maximum of 125 pounds and a total steam temperature of 450° F.

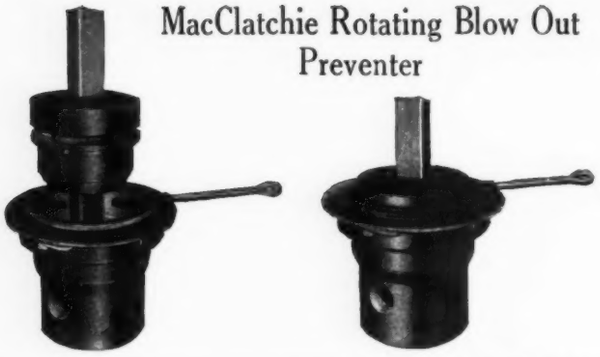
This trap is of the inverted bucket type, permitting intermittent discharge, unusually large capacity, and facilities for the elimination of air so that it positively will not air-bind.



It will operate in a positive manner without dribbling. Both pipe connections are made in a horizontal plane and directly into the body so that the cover and working parts can be removed without disturbing the piping connections. No complicated cover gaskets are necessary on account of this construction. After removing the cover, it is necessary to loosen only one screw in order to remove the valve, lever, bucket, and all other working parts.

For further information on the Apex Class ST, write the Apex Regulator Co., Division of Fisher Governor Co., Marshalltown, Iowa.

MacClatchie Rotating Blow Out Preventer



MacCLATCHIE MANUFACTURING COMPANY, Compton, Calif., has recently introduced a Rotating Blow Out Preventer, which they claim will withstand any pressure encountered in present-day drilling.

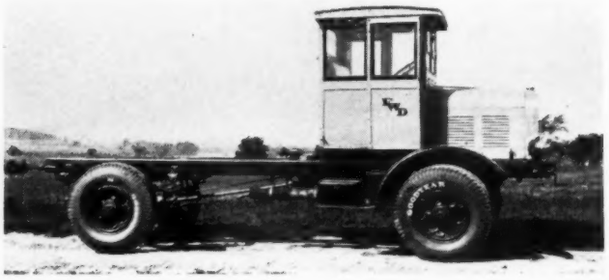
It is designed so there is no wear on the packing unless under pressure, at which time it is practically friction-proof from the packing. The packing packs off automatically, thereby eliminating the necessity of tightening packing glands.

The preventer is latched or unlatched by a rope running up to the derrick floor, thereby making it fast and easy to operate and eliminating the necessity of the crew going into the cellar to latch or pack it off.

The interior of the swivel is equipped with large rollers to take the side thrust and rotates on two large rows of ball bearings, thereby enabling it to carry the weight and to operate under pressure. All parts are heat treated, hardened or ground and the complete assemblies are tested to 4000 pounds cold water pressure before being shipped from the factor. The preventers are made for all sizes of casings and kellys.

FWD Truck Tests

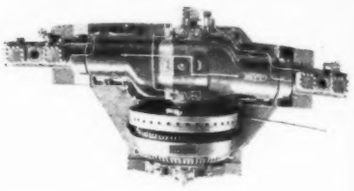
AN exhaustive test of an FWD four-wheel-drive truck has been conducted at Purdue University of Lafayette, Ind. The overall efficiency of the FWD, and the efficiency of the various units, such as axles and transmission were thoroughly tested. It was found that 11.8 per cent of the power developed by the motor was required to operate the truck, 88.2 per cent went into use for work, that is to say, it was used in moving or hauling heavy loads, or in negotiating bad roads.



Running at a speed of approximately 28 miles per hour, the brakes were applied and the truck was brought to a complete stop within the truck's own length. The average mileage per gallon of gasoline was 5.5 gallons per mile. The truck climbed grades of 78 per cent.

After these field tests, the laboratory efficiency test was conducted, in which it was found that the FWD truck was 88.2 per cent efficient.

Clark Balanced Opposed Compressor



CLARK BROS. CO., Olean, New York, announce a new balanced opposed compressor. This compressor has a two-throw 180 degree crankshaft so that the inertia forces cancel themselves at the crank pin, making a vibrationless compressor.

A number of these machines are in operation in the Lake Maracaibo district, mounted on piling in 30 feet of lake water, where there must be no vibration.

These machines are especially adapted for vapor recovery service where a masonry firewall between the compressor and the motor is desired as a fire safeguard. Two of the 500-horsepower size are now being installed in a large eastern refinery.

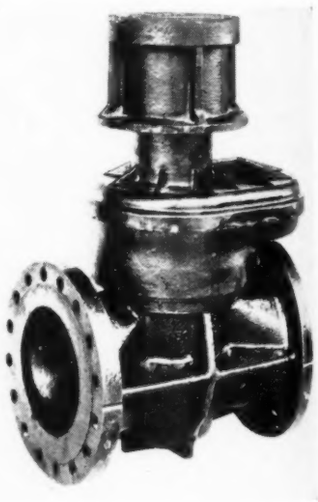
Universal Dual-Lok Joint Cast Iron Pipe

THE Central Foundry Company, Graybar Building, New York City, engineers, have developed the Universal Pipe Joint to a degree to meet the present day demand for a joint that is gas-tight under high pressures.

The new Universal Dual-Lok Joint Pipe retains all the characteristics of the Universal Pipe and is reinforced by a tight, flexible, non-deteriorating gasket that provides a double safety factor against leakage.

The pipe and joint are one structure, made of the highest grade, high tensile cast iron. The double safety against leakage is assured by accurate, tight, machined, iron-to-iron joint on the outside and a tight leak-proof gasket to iron joint on the inside.

Housing for Nordstrom Valves



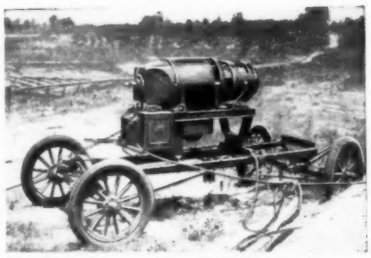
AS a measure of economy to eliminate the necessity of building expensive vaults for sub-surface valve installations, a new type of housing has been developed for Nordstrom valves, to properly protect the gears. A cast iron gear housing and road box can now be furnished for all Nordstrom spur-gear operated valves, according to the manufacturer, the Merco Nordstrom Valve Co., San Francisco, Calif.

This housing permits burial of the valves within an enclosure that fits snugly around the operating parts. Lubrication can be supplied to the valve from the surface by attachment of a low head extension projecting to the surface from the valve. Details are included in a new catalog recently produced by the company, copies of which can be obtained by addressing the company at any of its branch offices or at its headquarters.

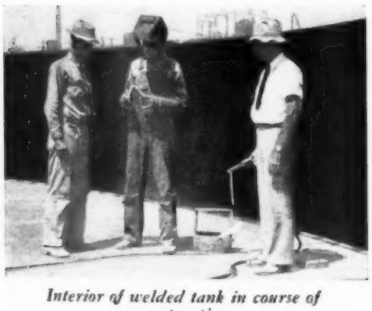
Large oil-storage tanks can be successfully welded

All-welded tank farm constructed by the Wyatt Metal and Boiler Works

Look at this record—*made with the new G-E arc welders and electrodes.*



One of seven new Type WD-24-400-ampere welders used in this installation



Interior of welded tank in course of construction

CONSTRUCTING 80,000-barrel storage tanks without a single rivet — that's what the Wyatt Metal and Boiler Works in Dallas, Texas, is doing with General Electric arc welders and welding electrodes.

The high-speed, high-quality welds of the new Type R, flexible-coated welding electrode, and nine Type WD arc welders, made possible the construction of 16 storage tanks — totaling 200,000 barrels capacity — in the record time of 45 days.

Arc welding is *going places* in every division of the oil industry. Are you making full use of this modern tool? Before you buy any welding equipment investigate the new G-E arc welding sets and the new G-E flexible-coated electrode, Type R. Just call the G-E office near you.

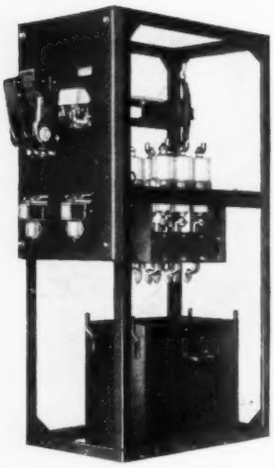
JOIN THE "G-E CIRCLE" — SUNDAYS AT 5:30 P.M. E.S.T. ON N.B.C. NETWORK OF 54 STATIONS — WEEK-DAYS (EXCEPT SATURDAY) AT NOON

530-121

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

Allen-Bradley Starting Switch



A THREE-POLE magnetically operated oil switch has been developed by the Allen-Bradley Company, 1311 S. First St., Milwaukee, Wis., for the starting of standard squirrel cage and high-reactance squirrel cage motors of ratings up to 750 horsepower, 2,500 volts. These switches, known as Bulletin *726*, may also be used as primary switches in connection with slip-ring motors having a 2,500-volt primary and rated up to 750 horsepower.

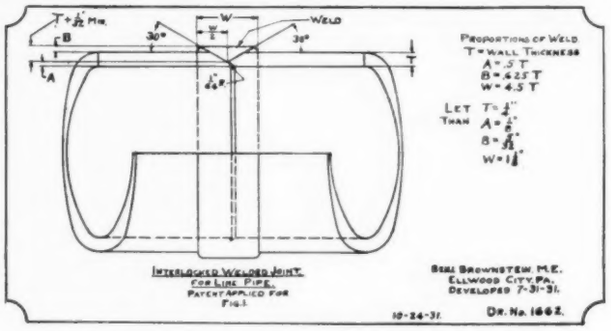
The switch is operated by closing the contacts of a push button, float switch, or other pilot control device. The closing of the pilot circuit causes a two-pole relay to close, which energizes the coil of the switch magnet and closes the switch, thereby connecting the motor directly across the line. The control circuits are of low voltage, allowing standard push buttons and other standard control accessories to be used.

Close and reliable overload protection is afforded by two combination magnetic-inducto-therm relays, adjustable for current tripping values. This is a new development in overload relays, combining the desirable features of both the magnetic relay and the resistance relay of the induction-type. This combination relay allows the full capacity of the motor to be utilized and at the same time gives close locked-rotor protection.

Interlocked Welded Joint

AN interlocked welded joint for line pipe has been developed by Benjamin Brownstein, mechanical engineer, of Ellwood City, Pa., according to the inventor. The joint is featured by its simplicity of construction, ease and economy of producing. It gives a stronger joint than the body of the pipe and a bore free from obstructions, whose resistance to the fluid flow is no greater than at any other part of the pipe.

The male and female beveled ends of the pipe are interlocked and self-supported, insuring alignment of the bores of the pipe sections before welding the joint. No special machines or equipment are required to produce this joint,

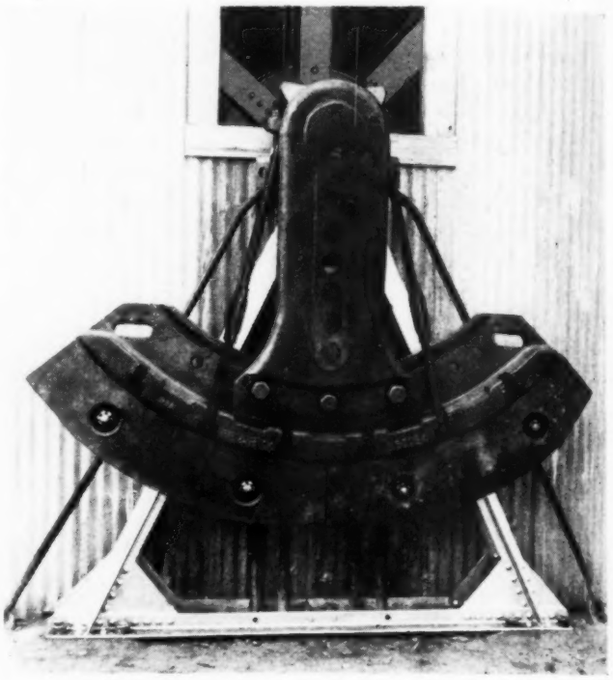


the only necessary machines are regular cutting-off machines, since they work in pairs one machine produces the male end and the other machine the female end of the joint. The angle of the beveled ends can be varied from 30 degrees to 45 degrees, inclusive, although 30 degrees gives the best proportions for interlocking and length of welding surface, and is the best suited for light weight pipe.

New Parkersburg Counterbalance

A NEW type of counterbalance has been put into production by The Parkersburg Rig & Reel Company, Parkersburg, W. Va. According to the manufacturer, field records have already demonstrated that the many distinctive features of this new pumping appliance contribute to economical and efficient pumping operations.

This counterbalanced crank, designated as type "C," consists of a crank member bored for six wrist pin openings to fit A. P. I. standard wrist pin, and is pressed on the crankshaft under heavy hydraulic pressure. Strokes up to 72 inches are provided for. The outer end of the crank is carried out into a fantail shape and is provided with cast projections which fit similarly shaped recesses in the main weight of the counterbalance.



On the back side of the crank is a cast tongue which fits a groove near the top of the main weight. The bosses on the end of the crank absorb all torque strains and the tongue and groove arrangement absorbs the weight of the main and auxiliary weights. These exclusive features minimize the strain on the bolts that attach the main weight to the crank and thereby prevent the development of looseness or play.

The simplicity of the design and the compactness of the entire assembly is such as to make the engagement or disengagement of weights (both main and auxiliary) a matter of but a few minutes' time. When disengaged, the weights are suspended from hanger rods attached to the jack post bearing, or if the installation consists of a unit with concrete foundation, they are supported on two pins set in the foundation. The proper lead or lag can be obtained by a simple adjustment of the main weight.

Auxiliary weights can be removed or added to produce the proper counterbalancing effect. The effective counterbalance weight at the sixth hole ranges from 3,800 pounds to 5,600 pounds. Additional details will be supplied by the manufacturer upon request.

Shielded
against Meddling

THE Fulton Spring-Type High-Pressure Regulator is recommended where individual users are to be supplied from a line carrying a pressure too high for a single regulator to hold with safety. It will take any inlet pressure up to 300 pounds and reduce it to any desired pressure between 10 and 50 pounds.

Compact and economical for transportation, simply designed for quick connection or adjustment, heavily and strongly built for durability in use—it is perhaps most of all commended by its safety from accidental or intentional meddling when in an exposed location. A descriptive leaflet is available. Advice as to application of any C-F appliance gladly given on request.

CF **The Chaplin-Fulton Manufacturing Co.**
28-40 PENN AVE. PITTSBURGH, PA.

FULTON
Spring-Type, High-Pressure
REGULATORS

B-M-W PRODUCTS for pumping wells
The KEY to LOWER LIFTING COSTS
CORRECTLY DESIGNED • • ECONOMICALLY PRODUCED
REASONABLY PRICED

B-M-W NEILSON LATCH SOCKET

This unit is designed to pass completely over and catch under the boxes of all sucker rods up to the capacity of opening in bowl. It is designed to give a straight end pull so the bowl will not bulge as will be found common with other sockets.

Parts made to pattern and fit perfectly and are heat-treated to insure long wear. Parts are interchangeable with respective size sockets.

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. . . For use in the Pictorial Petroleum Section, The Petroleum Engineer desires unusual and interesting photographs. These may be of field scenes, new installations, new hook-ups, individuals, or any subjects likely to appeal to men in the petroleum industry. Especially do we want pictures of "old-timers" who are still active in the business and views with a foreign setting.

If you have such photographs, we shall appreciate your permitting us to reproduce them in our pictorial section. Extreme care will be exercised in handling them and they will be returned in the same condition as received. Kindly address photographs to

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Abuse of the Gasoline Tax

THE owners of the 26,000,000 motor vehicles in the United States paid over $1,022,000,000.00 in taxes in 1931. This was nearly 10% of all taxes paid in the United States. The major source of this revenue was the gasoline tax levied by the States and ranging from two to eight cents per gallon.

The gasoline tax has reached confiscatory proportions and is consequently depressing to the vanishing point the ability of many motorists to own and operate their cars.

The Nation is looking to the automotive and oil industries to lead the way out of the depression. But the hope will be in vain if present and prospective car owners are to be confronted with a tax beyond their ability to pay.

Gasoline is now the highest taxed of all the useful commodities and any increase in the tax would aggravate an already intolerable condition. Note the following from the American Automobile Association:

> "As a result of the pyramiding of the tax, the racketeer has entered the field and is doing a big-time business. The racket is well organized. In all probability, the amount of gasoline money lost through evasion of the tax now considerably exceeds the revenue loss to road-building through diversion. It is safe to say that in 1931, gasoline bootleggers stole $40,000,000 of money paid by highway users, while our lawmakers have dipped their hands into the funds to the extent of close to $20,000,000 for purposes of general state administration. Thus, evasion and diversion of gasoline taxes have, in the twelve-month period, accounted for a loss of some $60,000,000 of road-building money, sufficient to build a standard, concrete two-line highway from New York to Salt Lake City, a distance of 2400 miles."

In the face of these facts there is agitation in Congress for a Federal levy of one cent per gallon to take $165,000,000 additional from the motorist; thus increasing the diversion, adding additional incentive to evasion and augmenting the already palpable injustice.

This Association urges you to discuss this matter with your representatives in Congress.

MID-CONTINENT Oil & Gas Association

(This Space Contributed by a Member)

Treating Pennsyl va Kerosene With H

By GEO. M. KIRK
Ass't Supt., Pennsylvania Re

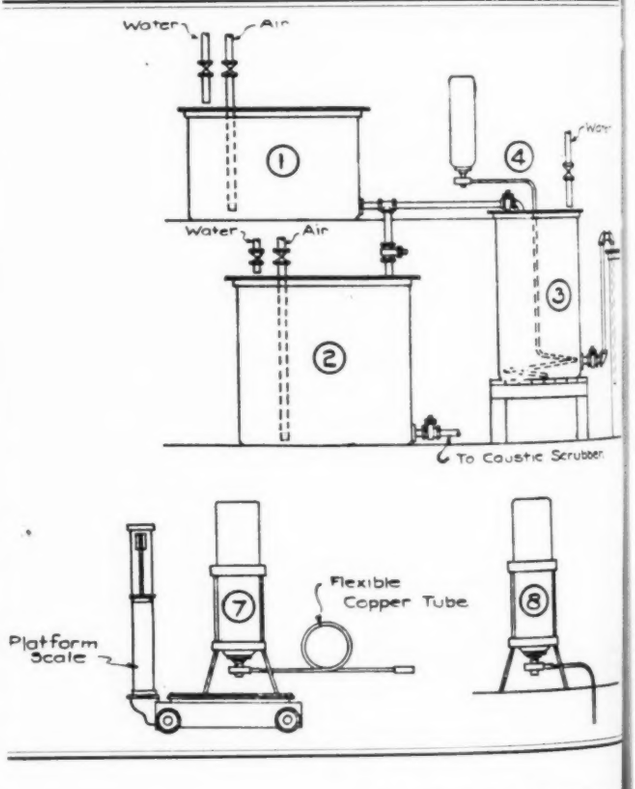
PREVIOUS to the installation of the continuous topping and vacuum unit, it was the custom at this plant to treat the gasoline and kerosene with sulphuric acid, neutralizing with caustic soda. This treatment was continued for some time after the installation of the tube still unit, although the distillates had changed considerably. The gasoline and kerosene are now both water white to start with and the distribution and character of the sulphur compounds have been changed.

The straight acid soda treatment did not produce a product which passed the doctor test, but it polymerized the mercaptans in the gasoline to the extent that, when rerun to make special naphthas, the distillates were sweet and the mercaptans were retained in the still bottoms. The kerosene after treating was all filtered through fuller's earth, which sweetened this product.

There were a number of disadvantages in the method of treating. In the first place, the cost was high, even though but a light acid treat was necessary. It involved the danger in handling sulphuric acid, and the problem of sludge disposal was annoying.

These considerations led to a program of experimental work which resulted in the adoption of the hypochloride process.

The hypochlorite solution is made fresh every day. Eighty gallons of 14-degree Be. caustic soda are transferred to make-up tank and diluted to 200 gallons. The chlorine cylinder is placed in a holder on the platform scale with the valve down and a connection made with copper tubing run-



vania Gasoline and Hypochlorite

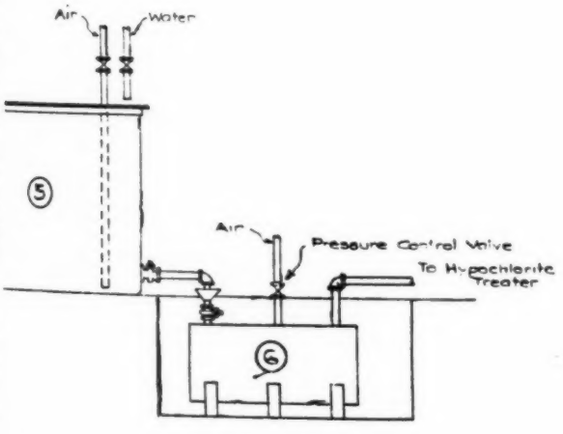
KIRKWOOD,
nia Refining Company

ning to the bottom of the make-up tank. Fifty pounds of chlorine are then added to the caustic soda at such a rate that no chlorine passes through into the air. This takes about an hour.

The first step in treating is a thirty-minute wash with forty gallons of 14-degree Be. caustic soda. After settling this is drawn off and 800 gallons of water added to the agitator, the purpose of this being to dilute the hypochlorite which works best in dilute solutions. The hypochlorite is then added and agitation continued for two hours. This is longer than necessary to secure a sweet product, but greater sulphur removal is effected. After settling the hypochlorite solution is drawn off and the treat is washed with water for about fifteen minutes. The same procedure up to this point is used for both gasoline and kerosene. The product in both cases is sweet, non-corrosive, and pleasant smelling, but is slightly off color, due to the oxidizing effect of the hypochlorite.

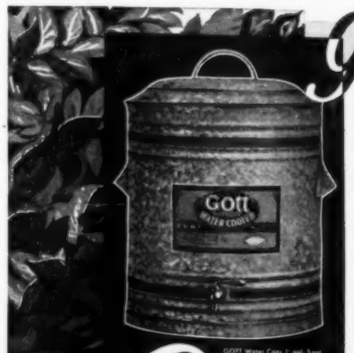
The gasoline is rerun in a batch still with a fractionating tower to make special naphthas, which require only a slight caustic wash and are water white, sweet and non-corrosive. The kerosene is filtered to water white color through fuller's earth.

The above outlined treating method has been used for about nine months and is very satisfactory. The treating time was greatly reduced, there are no sludges to contend with, no great care is needed in treating, and the finished product meets all requirements, the sulphur content being exceptionally low.



1, Caustic soda melt tank; 2, caustic soda dilution tank; 3, chlorinating tank; 4, chlorine cylinder fittings and diffuser; 5, hypochlorite dilution tank; 6, blow case; 7, cylinder hook-up for weighing out small amounts of chlorine; 8, cylinder hook-up for discharging total contents.

Gott WATER CANS & COOLERS



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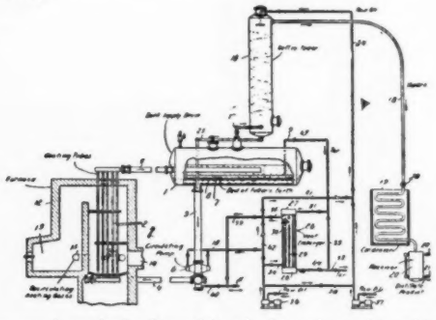
NEW PATENTS OF THE INDUSTRY

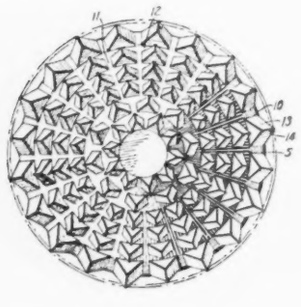
1,832,995. OIL PUMP. WILLIAM D. OGLETREE, Tulsa, Okla. Filed Sept. 4, 1926. Serial No. 133,583. 6 Claims. (Cl. 103—179.)

1. A pump of the character described including a barrel having a recess formed therein to provide an interior by-pass, heads secured within the barrel above and below the by-pass and having passages therein, valves for controlling the passages through the heads, a plunger operable in the Barrel between the heads, said plunger being adapted to be positioned adjacent the by-pass for relieving pressure thereabove, and means for opening the valves controlling the passages through the heads upon movement of the plunger.

1,826,782. ART OF CRACKING HYDROCARBONS. EUGENE C. HERTHEL, Chicago, Ill., and HARRY L. PELZER, Highland, Ind., assignors to Sinclair Refining Company, New York, N. Y., a Corporation of Maine. Filed June 11, 1927. Serial No. 198-247. 13 Claims. (Cl. 196—59.)



1. An improved method of cracking hydrocarbon oils, which comprises circulating a charge of oil in a pressure still from a bulk supply drum through heating tubes and back to the bulk supply drum and heating it to a cracking temperature in the heating tubes, maintaining a bed of finely divided solid material extending entirely across the path of the circulating charge of oil in the bulk supply drum, taking off vapors from the bulk supply drum under pressure and subjecting them to a refluxing operation, introducing raw oil into the vapors in the refluxing operation and returning reflux therefrom together with admixed unvaporized raw oil to the circulating charge of oil, discharging pitch-laden oil from the circulating charge of oil and preheating raw oil by heat exchange therewith, and supplying raw oil so preheated directly to the circulating charge of oil.

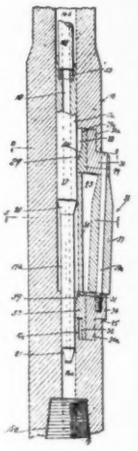


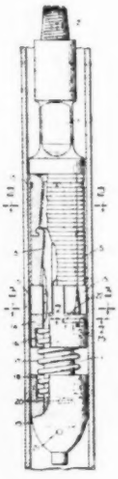
1,840,390. ROCK BIT CONE. GEORGE E. FAILING, Enid, Okla., assignor to Garber Tool Company, Garber, Okla., a Corporation of Oklahoma; E. A. Reed trustee of said corporation, bankrupt. Filed July 28, 1930. Serial No. 471,220. 5 Claims. (Cl. 255—71.)

1. A cone of the character described having teeth arranged in circular rows, each row comprising teeth regularly spaced but of unequal height.

1,839,588. PLUNGER ACTUATED UNDERREAMER, EDWARD F. RAYMOND, Long Beach, Calif., assignor to John Grant, Los Angeles, Calif. Filed Sept. 20, 1929. Serial No. 393,953. 9 Claims. (Cl. 255—74.)

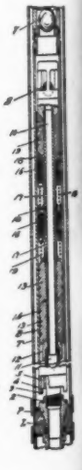
5. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter mounted on said body, a radially movable cutter supporting assembly comprising means for mounting said cutter for lateral swinging movement relative to the body, and a vertically movable plunger within the body adapted to be actuated by an object dropped within the drill pipe to move said cutter assembly radially.





1,839,493. FISHING TOOL. ORDA D. NUTTER, Parkersburg, W. Va., assignor to Acme Fishing Tool Company, Parkersburg, W. Va., a Corporation of West Virginia. Filed May 29, 1929. Serial No. 366,804. Renewed June 10, 1931. 14 Claims. (Cl. 294—96.)

1. A spear comprising a body, a series of seats longitudinally arranged thereon, each seat being at an angle to the body axis, and a series of slips engaging the series of seats and capable of movement thereon, the series of slips having an uninterrupted outer serrated face, the individual slips of the series being detachably connected together.

1,840,432. PUMP. PATRICK H. BRAY, Long Beach, Calif. Filed Feb. 4, 1929. Serial No. 337,340. 3 Claims. (Cl. 103—204.)

1. The combination, with a pump of the class having a standing guide column with a working valve and a valved traveling barrel, running on said column; of a bottom guide, on said barrel, running on said column and having a bottom face forming a coupler, and an anchor for the column presenting directly to said coupler face a top face forming a complementary coupling to be non-rotatively interlocked with the lower guide coupler.